UNITED STATE ENVIRONMENTAL PROTECTION AGENCY
REGION 5

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Subject: **Technical Review Comments on "Dissolved Phase Ground Water Investigation Report" Hartford Area Hydrocarbon Plume Site, Hartford, Illinois Sent by e-mail only**

Dear Sirs:

U.S. EPA submits the following technical comments to the Hartford Working Group. These comments are a compilation of technical reviews by the U.S. EPA, Illinois EPA, and Tetra Tech. U.S. EPA understands that the HWG is currently working on field-testing, expansion of the area wide SVE system and submittal of the LNAPL recovery design and is willing to discuss a proposed date to respond the attached comments and to initiate field work. U.S. EPA proposes that the HWG respond back to U.S. EPA by the August 9th conference call with a schedule and that field investigation work begin in the fall of 2006. Discussion and agreement of a timeline can be discussed at that time.

General Comments

1. Contrary to statements made in the Dissolve Phase Groundwater Investigation Report, the U.S. EPA does not feel that the true extent of the dissolved phase plume has been fully delineated. Wells on the south side of the Village do not appear to delineate the edge of the dissolved phase plume. It may be important to better delineate the southern boundary of the plume in order to evaluate the rate at which the plume might begin to shrink once the LNAPL remedy has been installed

2. The nature of the lead contamination present in the dissolved phase has not been clearly established such that the related risks can be accurately surmised. The

nature and extent of metals, particularly lead, which was used as an additive to gasoline may change the expected risk associated with the dissolved phase. Lead speciation may be prudent to evaluate its potential impact to human health and the environment.

3. Hydrologic gradients, which act as dissolved phase drivers, are undetermined to the east, northeast and north of the site, as well as the interaction of these gradients with gradients more proximal to the Mississippi River. An attempt should be made to capture existing data from these areas or identify wells that can be brought into the monitoring network.

4. Proposed multiple depth wells are not screened deep enough into the Main Sand. Multilevel wells should include screens that are placed at least as deep as those of the water supply wells to assure nothing is missed. This is particularly true should pumping ever cease in the Hartford area and gradients allowed to return to their original patterns (i.e. towards the river). Wells HMW-25 through 29 should be twinned with some deeper screened intervals.

5. LNAPL has been documented at nearly 60 feet below ground surface at the site below the main plume. In addition, the head pressure from the LNAPL plume and other forces can drive contamination well below the water table. Multilevel wells should be installed in the LNAPL plume to evaluate the vertical extent of the dissolved phase plume as the LNAPL plume shrinks.

6. Localized influences from the river will increase with proximity. The investigation should use any existing wells near the river to expand the understanding of how flow conditions changes, particularly deeper in the main sand in proximity to the river.

<u>Specific Comments</u>

1. Pipelines are identified as a major potential source of both product and dissolved phase hydrocarbons. However, recent ROST data collected along the Elm Street pipeline corridor demonstrate that wells must be almost right underneath the pipelines to detect contaminant sources because of the lithology in these areas allows for the rapid vertical and horizontal migration of contaminants from the pipeline into the underlying more permeable strata. Wells should be placed as close to these corridors as possible to identify and monitor releases. Currently, dissolved phase wells are at least a block away from the Elm Street or River Dock Pipeline corridor (See Figure 6-2 of the Report). The Rand Avenue including the "Hartford Wood River Terminal" corridors and the River pipeline corridors should be targeted as places for aggressive monitoring based on their apparent impacts to the plume beneath the Village.

2. Individual plume maps showing the nature and extent of dissolved phase constituents that might drive the need for potential cleanup or impacts to the river should be prepared. A map should be prepared with box plots that attempt to show the nature and extent of dissolved phase contamination above potentially applicable regulatory threshold limit values.

3. The dissolved phase plume should be compared with the historical and most recent vapor data to assess the correlation. Analysis of the "halo", high concentrations of dissolved phase product at the edge of the LNAPL plume should be assessed. A map overlay of the dissolved phase plume and vapor concentrations should be produced.

4. Page (vi), paragraph 3, line 3. This sentence seems to imply that sometimes the EPA stratum is not connected to the Main Sand. Please correct or clarify.

5. Page (vii), paragraph 3, bullet 2 and page (7-1), paragraph 2, bullet 4. This statement is incorrect. BTEX has been detected at locations HROST-119, 120 and 121. These locations are close to municipal wells.

6. Page (vii), paragraph 1, bullet 1. This statement is incorrect. Locations HROST-119, 120 and 121 which are south of Hawthorne Street have been impacted by BTEX. In addition, HROST-57 and HROST -119 groundwater grab samples indicated benzene levels at 14.0mg/l and 128 mg/l respectively. This area to the south of Hawthorn and along South Olive needs to be better defined by placing monitoring wells and conducting sampling. The report mentions the placement of peizometers only. This is unacceptable.

7. Page (vii), paragraph 3, bullet 3 and page (2-4), paragraph 4, line 8. The sentence states that sentinel wells have never been impacted by contaminants of potential concern (COPC). Lead is a COPC and Section 5.6 states that it has been detected in sentinel wells HMW-26, 28 and 29 at concentrations exceeding its comparison value. The lead exceedance, and the suggestion that it might not be site-related should be mentioned here.

8. Page (2-3), paragraph 3, line 2. Please reconsider statement. The flow divide in the Rand stratum is not evident on Figure 5-13.

9. Figure 2-8. This figure is not in agreement with Figure 5-13.

10. Page (5-3), paragraph 4, line 4. This sentence seems to imply that the dissolved phase in the southern portion of the site has not been impacted. This statement is incorrect. Figure 5-6 shows that locations HROST-119, 120 and 121 and groundwater grab samples from HROST-57 and HROST-119 have been impacted. Please revise this sentence to make mention of this.

11. Figure 5-6. The interpretive extent of LNAPL on this figure should be revised to include the following locations:

- HROST-82 (Maximum fluorescence = 328%; Table 4-1 says product observed in main sand)
- HROST-83 (Maximum fluorescence = 336%; Table 4-1 says product observed in main sand)
- HROST-85 (Maximum fluorescence = 477%; Table 4-1 says product observed in main sand)
- HROST-87 (Maximum fluorescence = 278% which is higher than the maximum fluorescence at location HROST-122 [258%] which is within the known extent of LNAPL)
- HROST-88 (Maximum fluorescence = 231%; Table 4-1 says product observed in main sand)
- HROST-118 (BTEX concentration 19,341 μg/L at 33 feet below ground surface)

Additional Investigations and Monitoring:

The agencies request that additional dissolved phase investigation work and monitoring be completed in the following areas.

North West Corner near Rand and Old St. Louis to N. Olive Street: In addition to the proposed wells (HWM-55 and HWM-56) determine the vertical and horizontal extent of the dissolved phase beneath the area. In addition, assess the movement of the dissolved phase plume, identify the source of the MTBE contamination, and to delineate the edge of the dissolved phase plume from the levee at Old St. Louis road to N. Olive Street.

Pipeline Corridors: Additional assessment is required in the Elm Street pipeline corridor, Rand corridor, and North Olive corridor.

South East corner of the site(South of Hawthorn along South Olive running west along 1st and 2nd Street. This area has shown benzene contamination in groundwater grab samples and further investigation is required to define the horizontal and vertical extent.

Area between HMW-51C and MP81C (W. Elm Street) and the area between MP-81C and HMW-26. Additional groundwater investigation will be required to define the horizontal and vertical extent.

Area between HMW-26 and MP-59A/c (W. Watkins Street): Additional ground water investigations will be required.

Additional Monitoring:

The attached monitoring points should be included in the quarterly monitoring plan:

a. MP-62C
b. MP-63C
c. HB38

d. MP-31C
e. HMW-41B

If you have any questions or need further explanation of any of the above comments please feel free to contact me at 618-997-0115 or Steve Faryan at 312-353-9351.

Sincerely,

Kevin Turner and Steve Faryan
On-Scene Coordinator's
U.S. EPA - Region 5

cc Brian Barwick, U.S. EPA ORC
Chris Cahnovsky, Illinois EPA
Tom Binz, Tetra Tech

Dissolved Phase Groundwater Investigation Report

Volume 1 of 3: Text, Figures and Graphs

The Hartford Area Hydrocarbon Plume Site
Hartford, Illinois

January 4, 2006
Clayton Project No. 15-03095.14-011

Prepared for:
The Hartford Working Group
Hartford, Illinois

Monte M. Nienkerk
Expires 3/31/2007

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EXECUTIVE SUMMARY

This Dissolved Phase Groundwater Investigation Report, prepared for The Hartford Area Hydrocarbon Plume Site (Site) in Hartford, Illinois focused on the nature and extent of the dissolved phase petroleum hydrocarbon plume to assess the threat posed by contaminated groundwater to human health and the environment and to facilitate the development of appropriate remedial approaches. The dissolved phase plume has formed as a result of the presence of light non-aqueous phase liquid (LNAPL), first identified in 1978, in northern Hartford.

The Site geology consists of alternating alluvial deposits of clay and silt. This alluvium overlies alluvial sands and sandy glacial outwash that ranges from 60 to 150 feet thick and is known locally as the Main Sand. The overlying permeable zones within the alluvium are locally known (in descending order) as the North Olive, the Rand, and the EPA Strata. These deposits are overlain and bounded by several clay deposits identified (in descending order) as the A Clay Stratum, which overlies the entire Site, and localized deposits of the B Clay, the C Clay, and the D Clay Strata. The regionally extensive Main Sand underlies the fine-grained alluvial deposits.

During the period of October 2004 through October 2005, groundwater within the North Olive and Rand Strata occurred as isolated areas of perched water, though immediately northeast of the Site, groundwater in the Rand Stratum appeared to be confined. Groundwater in the EPA Stratum, during this period, has been confined and hydraulically connected to the Main Sand. The Rand and EPA Strata both reflected a groundwater divide immediately northeast of the Site. The divides trended along a general northwest/southeast axis; on the southern side groundwater flowed in a southwesterly direction and on the northern side groundwater flowed in a northeasterly direction. As groundwater in the EPA Stratum flowed southwesterly beyond the extent of the underlying D Clay Stratum, it merged with the Main Sand groundwater flow. Groundwater in the Main Sand, during this period, was confined where it underlies the C Clay and the D Clay Strata in the northern area of Hartford. However, the Main Sand became unconfined generally south of West Date and East Forest Streets. The local groundwater flow in the Main Sand has generally been to the north-northwest due to large-scale water pumping for industrial production processes located north of the Site.

The extent of the dissolved phase plume has been defined within the available area of investigation. The following findings are consistent with the northerly groundwater flow at the Site.

- The dissolved phase plume is approximately bounded by Hawthorne Street to the south. It is also approximately bounded by Illinois Route 3 along a portion of the western plume boundary, specifically, the southern portion.
- The dissolved phase plume to the south and portions of the west is largely limited to areas of residual LNAPL (which has been reasonably defined with the Rapid Optical Screening Tool [ROST ™]).
- The dissolved phase plume extends beyond the Site along the eastern, northern and remaining northern portion of the western plume boundary
- The groundwater screening investigation revealed that the highest concentrations of Methyl-tert-butyl-ether (MTBE) are found north of Rand Avenue.

Based on current conditions and the long-term existence of the LNAPL at the Site, the dissolved phase plume is expected to continue to form a narrow "halo" around the southern and the majority of the western portions of the LNAPL with similar dissolved phase conditions anticipated along the remaining LNAPL boundaries.

The LNAPL has not impacted the area of the Hartford Municipal Wells based on the followings findings:

- No indications of LNAPL have been observed near the Hartford municipal wells.
- No indications of dissolved phase hydrocarbons were identified near the Hartford municipal wells.
- Sentinel wells have shown no indications of impact from the LNAPL and associated dissolved phase plume since their installation in December 2003.
- Groundwater flow in the Main Sand Aquifer, based on a review of both historical and recent flow mapping data, has consistently been northerly away from the Hartford municipal wells. No pumping influence by the municipal wells beyond their immediate area has been identified, and none is anticipated based on the daily short-term pumping operations of these wells.

Based on current conditions and the long-term existence of the LNAPL and dissolved phase plumes in northern Hartford, it is considered highly unlikely that the Hartford Municipal Wells will be impacted by the LNAPL.

This report is based on data available at the time of its preparation and recommends continued groundwater monitoring to verify the understanding of groundwater flow and the dissolved phase plume.

1.0 INTRODUCTION/PURPOSE

This Dissolved Phase Groundwater Investigation Report (Groundwater Report) was prepared on behalf of the Hartford Working Group (HWG) to meet the requirements of Paragraph 51 of the Administrative Order on Consent (AOC) with the United States Environmental Protection Agency (USEPA) in the matter of The Hartford Area Hydrocarbon Plume Site (Site) (Docket No. R7003-5-04-001) (USEPA, undated). Clayton Group Services, Inc., *A Bureau Veritas Company* (Clayton), was retained by the HWG to prepare the Dissolved Phase Groundwater Investigation Report (Groundwater Report). The HWG is comprised of the Atlantic Richfield Company (Atlantic Richfield), The Premcor Refining Group Inc. (Premcor), Shell Oil Products US (Shell) and Sinclair Oil Corporation (Sinclair). An evaluation of the dissolved phase hydrocarbon-impacted groundwater is necessary to enhance the Conceptual Site Model (CSM) and support determination of an appropriate remedial approach.

The activities presented in this Groundwater Report were completed in accordance with the May 24, 2005 Dissolved Phase Groundwater Investigation Work Plan (Work Plan) prepared by Clayton (2005a). The Work Plan addressed the dissolved phase hydrocarbon constituents associated with the identified light non-aqueous phase liquid (LNAPL) located in the northern portion of Hartford, Illinois (Clayton 2005a). LNAPL is an environmental industry term used to identify the presence of nonaqueous (not dissolved) phase liquid petroleum that may or may not be of sufficient saturation and volume in the subsurface to flow into a well. LNAPL which is not of sufficient saturation and volume to flow into a well is termed residual LNAPL in this report. Most petroleum compounds have relatively low solubilities in water, the most notable exceptions being benzene, ethylbenzene, toluene and xylenes (BETX). Regional groundwater quality standards (35 Illinois Administrative Code [IAC] 620) have been established by the State of Illinois for these compounds based on their potential to affect human health and the environment. These standards are not established remediation objectives or cleanup values for the Site, but are referenced as comparison values only; and thus, will be referred to as "comparison values" throughout this report.

The objectives of the investigation were (1) to delineate the dissolved phase hydrocarbon plume adjacent to the LNAPL, (2) to define areas where vapor intrusion from dissolved phase hydrocarbon constituents could potentially impact residential homes or other buildings, (3) to delineate the dissolved phase hydrocarbon plume in the direction of the Hartford municipal water supply wells, and (4) to collect data to verify the understanding of groundwater flow near the active Hartford municipal wells.

Data collected by Clayton from 2003 through October 2005 regarding the nature and extent of the dissolved phase hydrocarbon plume is presented in this Groundwater Report. This Groundwater Report presents known information and data available at the time of its preparation.

This report also presents the proposed continued groundwater monitoring to verify the understanding of groundwater flow and to enhance the understanding of the dissolved phase groundwater plume. The continued groundwater monitoring will include the following:

- Installation of a nest of piezometers south of the LNAPL to further assess groundwater flow in the deep Main Sand and potential vertical flow gradients, in the relative vicinity of the Hartford municipal wells. These activities will also enhance the Hartford geological and hydrogeological databases.
- Installation of nested monitoring wells at selected areas bounding the LNAPL to further assess groundwater quality and flow, both horizontally and vertically, in northern Hartford. These activities will also enhance the Hartford geological and hydrogeological databases.
- Gauging of selected piezometers/monitoring wells on a quarterly basis, including the new nested piezometers and wells, to monitor groundwater flow in the more permeable units (Rand, EPA and Main Sand Strata).
- Groundwater sampling and analyses of selected monitoring wells (without LNAPL) on a quarterly basis, including the new nested wells, to monitor the dissolved phase hydrocarbon plume in Hartford.

2.0 SITE DESCRIPTION

2.1 LOCATION AND SETTING

Hartford, Illinois is located in Madison County near the east bank of the Mississippi River, upstream from St. Louis, Missouri. Hartford lies approximately 3,000 feet east of the Mississippi River. The Shell Oil Company Tannery property and the Premcor Terminal/Former Refinery facility are located directly east of Hartford while the Shell Rand Avenue Site is located to the northeast of Hartford. The Hartford Wood River Terminal is located directly north of Hartford, across Rand Avenue. The BP (fka Amoco) Former Refinery Facility is located north-northeast of Hartford across Rand Avenue. The ConocoPhillips facility (former Shell facility) is located east of the Premcor Facility with a portion also abutting the north boundary of Premcor. Numerous underground petroleum pipelines are present in the area, including three areas (Elm Street, North Olive Street and Rand Avenue) located in the northern portion of Hartford. The general location of Hartford, Illinois, along with the Site and adjoining property boundaries, are shown in Figure 2-1.

Hartford is within a geographical region collectively known as the American Bottoms (Schict 1965). The American Bottoms consists of unconsolidated valley fill deposits ranging up to 170 feet thick. The uppermost geologic unit is the Cahokia Alluvium, which consists of sands, silts, and clays of channel, floodplain, and modern river origin. The Mackinaw Member of the Henry Formation, a sandy glacial outwash deposit, underlies the Cahokia Alluvium. The Cahokia sands and Henry Formation outwash deposits range in thickness from 60 to 150 feet. These deposits comprise the most extensive and thickest aquifer in the region. In the Hartford area, this aquifer is referred to as the Main Sand.

The Hartford Site boundaries have been defined in the AOC as being bounded by Rand Avenue to the north, the nearest railroad tracks along the east side of Olive Street to the east, Donna Drive and the south boundary of Hartford Park to the south, and Illinois State Highway 3 to the west. The Hartford Site boundaries may differ from the Hartford corporate boundaries.

2.2 SITE HISTORY AND PREVIOUS WORK

In general, the environmental concerns are located within an area bounded by Hawthorne Street to the south, North Olive Street to the east, Illinois State Highway 3 to the west, and Rand Avenue to the north (Figure 2-2). In 1978, petroleum was identified in monitoring wells beneath northern Hartford, resulting in the implementation of hydrocarbon recovery efforts (Figure 2-3). Subsequent monitoring well gauging events were conducted in 1982 and 1990 (Figures 2-4 and 2-5, respectively). The 1982 LNAPL extent depiction was similar to the 1978 figure. In 1990, the LNAPL extent was shown as being significantly smaller. Based on these historical depictions, the extent of LNAPL on the groundwater surface appears to have been reduced due to the LNAPL recovery efforts that began in 1978.

2.3 GEOLOGY

The primary aquifer in the north Hartford area is the Main Sand, and it is the primary focus of the dissolved phase investigation. However, a number of geologic strata overlie the Main Sand. The geologic units consist of alternating alluvial deposits of clay and silt overlying the regionally extensive Main Sand (American Bottoms Aquifer). The permeable zones within the alluvial deposits are locally known (in descending order) as the North Olive, the Rand, and the EPA Strata. These deposits are overlain and bounded by several clay deposits identified (in descending order) as the A Clay, B Clay, C Clay, and D Clay Strata. The North Olive and Rand Strata laterally grade into and are hydraulically connected with the Main Silt, where the B and C Clay Strata pinch out south of Watkins Street. The EPA Stratum grades laterally into the Main Sand to the south of a southeasterly trending line drawn from the Old St. Louis Road and Delmar Avenue intersection to just north of the East Date Street and North Olive Street intersection. Along this boundary the EPA Stratum and Main Sand are hydraulically connected. The upper portion of the Main Sand is known as the Main Silt as it is finer grained than the underlying Main Sand. Where the B and/or C Clay Strata are absent, the Main Silt is hydraulically connected to the Main Sand. The geology and hydrogeology of northern Hartford is illustrated in generalized cross-sections (Figure 2-6). A more detailed description of the Site geology is provided in the December 15, 2005 LNAPL CSM (Clayton 2005d).

The clay strata in Hartford consist primarily of clay and silt with trace amounts of sand. The uppermost clay deposit, the A Clay Stratum, is present throughout Hartford and overlies the North Olive Stratum.

The A Clay Stratum ranges in thickness from 5 to 24 feet. The B Clay Stratum (encountered ~ 12 to 27 feet below ground surface [bgs]) underlies and defines the extent of the North Olive Stratum and overlies the Rand Stratum. The B Clay Stratum ranges in thickness from less than 1 foot to 12 feet. The Rand Stratum is underlain by, and defined by the extent of the C Clay Stratum. The C Clay Stratum (encountered ~ 27 to 46 feet bgs) ranges in thickness from less than 1 foot to approximately 8 feet. The C Clay Stratum overlies the EPA Stratum, where present, and the Main Sand (encountered ~ 19 to 45 feet bgs). The D Clay Stratum underlies and defines the extent of the EPA Stratum, and overlies the Main Sand. The D Clay Stratum ranges in thickness from approximately 2 to 7 feet and could be considered a discontinuous lens within the Main Sand based on its relative thickness and limited extent.

2.4 HYDROGEOLOGY

Natural groundwater movement within the American Bottoms is westerly, draining from the limestone bluffs (east wall of the floodplain valley) located east of Hartford, to the Mississippi River (Engineering-Science 1992). However, the natural movement of groundwater in the American Bottoms has been altered in the Hartford vicinity (Hartford, Roxana and Wood River) due to large-scale industrial water pumpage. The combined pumping rate from these areas is greater than 10,000 gallons per minute (GPM) (Farmayan et al., 1998). The withdrawal of water to be used in industrial production processes has created cones of depression in the water table in the vicinity of Hartford to the north (on BP property), and to the northeast and the northwest (on ConocoPhillips property). In addition, pumping is conducted at the Premcor Facility to the east and by the Village of Hartford within the southwestern portion of Hartford. In general, the net effect of this drawdown has altered flow in the Main Sand to the north and northwest across much of the Village. Flow in the Main Sand along the eastern portion of the Village has also been altered locally by pumping on the Premcor property.

A generalized groundwater flow direction map of the Main Sand Stratum indicates north/northwesterly flow at the Site (Figure 2-7). A generalized groundwater flow direction map of the Rand Stratum indicates the presence of a groundwater divide, located northeast of the Site and trending along a general northwest/southeast axis (Figure 2-8). Groundwater on the northern side of the divide flows in a northeasterly direction while flow on the southern side of the divide is in a southwesterly direction. Conditions in the EPA Stratum are similar. The generalized groundwater flow direction map of the EPA Stratum also indicates the presence of a groundwater divide northeast of the Site and trending along a general northwest/southeast axis (Figure 2-9). Again in this Stratum, groundwater on the northern side of the divide flows in a northeasterly direction while flow on the southern side of the divide is in a southwesterly direction. As shown in Figure 2-10, the general southwesterly groundwater flow in the EPA, upon passing the underlying D Clay, enters the Main Sand Stratum and then becomes north/northwesterly.

In Hartford, groundwater appears to be confined where it underlies the C Clay Stratum and the D Clay Stratum; however, it becomes unconfined generally south of West Date and East Forest Streets. Unconfined groundwater occurs beyond the north, south, and east extent of the B/C Clay Stratum. Groundwater elevations within the Main Sand have been documented to fluctuate significantly over the years, ranging from approximately 416 (1993) to 380 (mid-1950s) feet mean sea level (MSL) (Clayton 2005c).

2.5 VILLAGE OF HARTFORD MUNICIPAL WELLS

The two active Hartford municipal wells have screen intervals of 87 to 107 (Well #3) and 71 to 106 (Well #4) feet bgs (Illinois State Water Survey 1971, 1977). According to Mr. Dana Daniels (2004) of the Hartford Water Department, the municipal wells are operated on an alternating monthly basis at a rate of approximately 400 gallons per minute; pumping of the active municipal well occurs approximately 8 to 10 hours per day (Daniels 2005). Well #4 was the active well during July and September 2005 while well #3 was operating during August 2005 (Daniels 2005). The wells are only pumped each day on an as-needed basis. Once the water tower and the clear well are full, the pump in the active well automatically shuts off. The pump can then only be restarted manually.

Five monitoring wells (HMW-25 through HMW-29) were installed in December 2003 to assess groundwater quality between the Hartford Well Head Protection Area (WHPA) and the known areas of petroleum-impacted groundwater related to the LNAPL at the Site (Clayton 2004a). The WHPA is the surface area near the two active Hartford municipal wells that may provide recharge to the aquifer over a five-year period (McGuire et al., 2001). These monitoring wells, known as sentinel wells, are located outside the known extent of LNAPL and dissolved phase petroleum constituents. The sentinel wells are monitored for indications of dissolved phase petroleum constituents on a quarterly basis in accordance with the AOC. The sentinel wells have never shown any impact resulting from encroachment of either

LNAPL or the associated dissolved phase plume. The locations of the sentinel wells and the WHPA are shown in Figure 2-2.

3.0 OCTOBER 2004 THROUGH NOVEMBER 2005 ADDITIONAL INVESTIGATION ACTIVITIES

Additional subsurface investigation activities also were conducted by Clayton from October 2004 through November 2005 as part of Vapor Control System (VCS) activities. The VCS is presently operating at the Site for vapor mitigation purposes. The additional monitoring locations resulting from these VCS-related activities have been incorporated into the ongoing gauging and sampling activities to evaluate groundwater flow and determine the extents of LNAPL (if present). In addition, Premcor installed a series of wells at three locations along North Olive Street in August 2005 as part of ongoing activities conducted at the Premcor Hartford Terminal. These new wells (HMW-series) have also been incorporated into ongoing gauging and sampling activities at the Site.

These activities have provided additional monitoring locations for the dissolved phase groundwater investigation through the installation of monitoring probes and wells in the Main Sand and the more permeable overlying strata (Figure 3-1). Groundwater results from the additional locations are presented in Section 5.2. Further details regarding the additional Site investigations are presented in Appendix A.

4.0 GROUNDWATER INVESTIGATION

Determining the status of the dissolved phase plume associated with the LNAPL underlying northern Hartford is necessary to enhance the CSM and support determination of an appropriate remedial approach for groundwater. The investigation extended into public right of ways beyond the Site boundaries and included work in all identified groundwater bearing permeable strata at the Site. The investigation addressed geological, hydrogeological, and groundwater flow-related data gaps in the northern portion of Hartford. Investigative activities were conducted primarily in existing streets and alleyways, within the limitations posed by public access right-of-ways and associated utilities. Access to non-public areas was dependent upon the ability to obtain agreements with current landowners.

Clayton's findings since 2004 (Clayton 2005a) have shown that the majority of the dissolved phase plume is in the Main Sand Stratum. A goal of the groundwater investigation was to identify the extent of the dissolved phase plume in order to identify areas where potential vapor intrusion from these dissolved constituents may potentially impact residential homes. Another goal was to delineate the southern boundary of the dissolved phase plume to determine potential encroachment upon the well head protection area (WHPA) and the Hartford municipal water supply wells which are located in the southern portion of Hartford.

The investigation included the following activities, which are discussed below (1) direct push multi-level groundwater sampling, (2) monitoring well groundwater sampling, (3) installation of piezometers near the Hartford municipal supply wells, (4) groundwater gauging, (5) in-situ hydraulic conductivity testing, and (6) investigating the previous detection of lead in the sentinel wells. The direct push (hydropunch) multi-level groundwater sampling is a screen tool for obtaining groundwater samples. Analytical results from this type of groundwater sampling (screening) can only be used for order of magnitude comparisons.

4.1 DIRECT PUSH MULTI-LEVEL GROUNDWATER INVESTIGATION

Investigative activities were conducted during the Summer of 2005 to enhance the understanding of the Site subsurface. This included portions of southern Hartford in the area of the Hartford municipal wells, which is discussed further in Section 4.3. The initial activities consisted of assessing the geology using cone-penetration testing (CPT). To further enhance the previous LNAPL investigation conducted by

Clayton in 2004 (Clayton 2004c), the Rapid Optical Screening Tool (ROST ™) technology was employed concurrently with the CPT to identify any residual petroleum hydrocarbons at the proposed groundwater sampling locations. The ROST technology was applied over the entire vertical extent of the boring. Subsequent activities consisted of discrete, multi-level groundwater sampling and the chemical analysis of groundwater samples.

The groundwater investigation consisted of direct push borings at select locations and was based primarily on the findings presented in Section 4.0 of the May 24, 2005 Work Plan (Clayton 2005a). The investigation area was primarily south (vicinity of Hawthorne Street corridor), west (vicinity of Illinois Route 3 and the Old St. Louis Road corridor), and northwest of the existing LNAPL underlying the Site. The groundwater investigation locations are presented in Figure 4-1. Locations were adjusted based on accessibility, clearances for utilities, and other field conditions.

As shown in Figure 4-1, several of the borings were within the identified area of LNAPL in the Main Sand. The primary purpose of these points was to obtain data on the nature of the LNAPL at these areas using the ROST™ technology. However, shallow strata above the Main Sand were also sampled at these locations if groundwater was present. No groundwater samples were collected within the Main Sand at LNAPL-containing boring locations to avoid potential cross-contamination from the overlying LNAPL during advancement of sampling equipment.

A total of 35 direct push multi-level groundwater sample locations were completed to determine the magnitude and extent of the dissolved phase hydrocarbons at and immediately adjacent to the Site. Included were locations expected to exhibit dissolved phase hydrocarbons as they were within the previously identified dissolved phase plume extents (Clayton 2005a); these locations were intended to fill in data gaps by providing vertical definition data. Additional locations were intended to provide the magnitude and extent of the dissolved phase hydrocarbons in areas where they had not been delineated.

The discrete multi-level sampling of any location was dependent upon the findings of the subsurface investigation. Specifically, if the more permeable units (the North Olive, the Rand, the EPA and the Main Sand Strata) were encountered and determined to be saturated, but did not have a ROST response indicative of the presence of significant amounts of LNAPL, samples were obtained to identify potential dissolved phase hydrocarbons within each strata. In addition, discrete vertical sampling continued within the Main Sand to determine whether dissolved phase hydrocarbons were present at depth within this stratum. The initial sampling depth within the Main Sand was at the surface of the saturated zone, which was encountered at approximately 30 feet bgs. Deeper Main Sand samples were typically collected between 40 to 50 feet bgs, 50 to 60 feet bgs, and at the maximum depth achievable by the equipment. The Main Sand sampling depths were guided by the findings of the investigation. Specifically, if distinctly more permeable or coarser zones were identified in the Main Sand, the groundwater sampling was biased to these depths. However, this approach was balanced by the need to obtain sufficient vertically distinct samples to identify whether dissolved phase hydrocarbons may be transported at depths below the LNAPL identified in the Main Sand.

Fugro Geosciences, Inc. (Fugro) of Houston, Texas, advanced the CPT borings to the depth limits of the rig to obtain geologic data. The upper 10 feet at each boring location was hand-augered to identify potential subsurface utilities prior to all drilling activities. CPT is a technique in which an electronically instrumented probe (in this case a piezocone probe) is advanced into the subsurface media using hydraulic rams mounted inside the CPT box truck. The piezocone probe contains gauges that continuously monitor tip resistance, friction ratio, and pore pressure. Tip resistance and friction ratio are used to determine the soil stratigraphy while pore pressure is used as an indicator of soil moisture. This data is plotted onto a log. Soil stratigraphy is then classified using *Campanella and Robertson's Simplified Soil Behavior Chart* (Robertson and Campanella, 1983). The CPT logs are presented in Appendix B.

Decontamination was conducted adjacent to each boring location and no soil cuttings were produced during the testing. The boring locations were sealed upon completion with bentonite.

The ROST™ portion of the investigation, also conducted by Fugro, was completed concurrently with the CPT activities to obtain screening data on the potential in-situ distribution of petroleum hydrocarbons in the soil matrix throughout the vadose, capillary fringe, and saturated zones at the boring locations. The technology consists of a tunable laser, mounted in the truck, which is connected by optical fibers to a down-hole sensor flush with the side of the piezocone probe. The laser creates a fluorescence response in polycyclic aromatic hydrocarbon (PAH) and some aromatic petroleum compounds as the probe is advanced. A portion of the fluorescence emitted is returned through the sensor to a detection system in the truck. The ROST data are continuously recorded. A proprietary petroleum hydrocarbon compound (PHC) containing reference solution was used for ROST calibration purposes.

Any emitted fluorescence is measured simultaneously at each of four monitoring wavelengths that cover the range of fluorescence produced, from light-range (shorter wavelength) to heavy-range (longer wavelength) petroleum hydrocarbons. The relative percentage of fluorescence at each of the four wavelengths is continuously measured. The results from the monitored wavelengths are combined, based on the relative fluorescence intensity percentages of each of the four wavelengths, and plotted on the ROST log. The emitted fluorescence of the four wavelengths is totaled and recorded as the fluorescence intensity (% RE). The ROST data are presented as a color graph of fluorescence intensity (% RE) versus depth (feet). The ROST data are subject to spectral interference including naturally occurring fluorescent minerals. The ROST logs are provided in Appendix C.

Discrete groundwater samples were collected from each of the 35 boring locations. The vertically discrete groundwater samples were collected using the CPT rig equipped with a Hydropunch (direct-push instrument). This technique involves pushing rods, which include a shielded, approximately 1.5-foot stainless steel screen attached to their ends, to the target depth. Once at the target depth, the shield is pulled back exposing the screen. Groundwater flows into the rods through the screen and tubing is lowered through the rod to retrieve the water sample.

Depending upon conditions encountered, the number of vertically discrete groundwater samples ranged from two to four at each of the sampled boring locations. In addition, quality control samples including four equipment blanks, 16 trip blanks, and eight duplicate samples were collected or prepared. The samples were submitted to Teklab for analysis. The groundwater samples, duplicates, equipment blanks, and trip blanks were analyzed for the dissolved phase hydrocarbon indicator parameters BETX and methyl-tert-butyl-ether (MTBE). The BETX and MTBE analysis was performed using USEPA SW-846 Method 5030/8260B.

The rationale for choosing vertically discrete groundwater sampling locations is presented in Table 4-1. In general, the rationale included an evaluation of the ROST logs and the subsurface geology depicted in the CPT logs. In the absence of any interpreted ROST indications of petroleum hydrocarbon, the samples were collected from depths interpreted to contain coarser material based on the CPT drilling. In those few instances where occasional ROST "peaks" were indicated at depth, but not in shallower saturated material, a sample was obtained from the depth of the "peak". The laboratory analytical results were transmitted electronically to the USEPA and the Illinois EPA as they were received from the laboratory. Paper copies of the laboratory analytical reports are maintained at Clayton's office in Downers Grove, Illinois.

Decontamination activities for the groundwater sampling equipment were conducted on secured Hartford property that had been prepared to serve as a laydown, temporary waste storage, and decontamination yard for the planned work. The boring locations were sealed upon completion with bentonite.

Additional step-out locations were conducted unless:

- Groundwater sample results for BETX and/or MTBE were below comparison values, or
- Groundwater sample results for BETX and/or MTBE demonstrated an increase in concentration gradients or change in composition indicating contribution from other sources.

4.2 MONITORING WELL GROUNDWATER SAMPLING

Quarterly groundwater sampling of the sentinel wells has been ongoing since December 2003. Beginning in late fall 2004, additional monitoring wells (installed as part of the LNAPL investigation) were included with the sentinel well sampling. During the quarterly groundwater sampling in April, July, and October 2005, 92 monitoring wells, which did not contain LNAPL, were sampled in an effort to enhance the understanding of dissolved phase hydrocarbon impacted groundwater. This sampling was conducted on wells screened in the Main Sand (62 wells), the EPA Stratum (7 wells), and where sufficient groundwater was present the Rand Stratum (20 wells), and (4) the North Olive Stratum (3 wells).

Monitoring well groundwater samples were collected using the low-flow sampling technique, including all those within the Main Sand, with the exception of wells containing insufficient water to sample in this manner. These samples were collected using bailers. Water quality indicator parameter records for the April, July and October 2005 sampling events are included in Appendix D. The low-flow groundwater sampling procedures have been revised to reflect recent USEPA guidance (see Appendix E).

Upon collection, groundwater samples were placed in laboratory-supplied, pre-preserved (if appropriate) containers. After collection, samples were immediately labeled, placed in a cooler containing ice, and delivered under chain-of-custody procedures to Teklab for laboratory analysis.

Monitoring well groundwater sample analyses included the "Skinner List" of hydrocarbons. Specifically, the sample analyses included the following parameters: Volatile Organic Compounds (VOCs) (including MTBE and EDB); 1,4-dioxane; Semi-Volatile Organic Compounds (SVOCs) including PAHs; metals; and general chemistry parameters including cyanide. The "Skinner List" of parameters, the practical quantitation limits (PQLs), and the analytical methods are presented in Table 4-2. The containers with applicable preservation requirements (if appropriate) for each parameter are presented in Table 4-3.

The 2005 laboratory analytical results were transmitted electronically to the USEPA and the Illinois EPA, as they were received from the laboratory. Paper copies of the laboratory analytical reports are maintained at Clayton's office in Downers Grove, Illinois.

Additional groundwater gauging, monitoring and decontamination details employed during sampling of the monitoring wells are provided in Standard Operating Procedures (SOPs) 220 and 500 (Clayton 2004a). These SOPs may be modified based on field conditions.

4.3 PIEZOMETER INSTALLATION NEAR HARTFORD MUNICIPAL SUPPLY WELLS

Piezometers were proposed in the May 24, 2005 Work Plan (Clayton 2005a) to enhance the understanding of the geology and the groundwater flow regime within the central portion of Hartford and in the area of the municipal supply wells. The municipal supply wells are located in the southwest portion of Hartford. Nine piezometer locations were proposed to assist in determining the influence municipal well pumping has on groundwater flow, primarily in regard to the LNAPL and associated dissolved phase plume located in northern Hartford. Selected piezometer locations (HP-1, HP-3, HP-4 and HP-5) were nested to enable evaluation of vertical gradients in addition to horizontal gradients. Figure 4-2 presents the piezometer locations. Clayton (2005c) previously presented details regarding the piezometer installations and findings.

The initial activities consisted of a subsurface investigation using CPT and ROST technologies and chemical analyses of vertically discrete groundwater grab samples from the nine piezometer locations. The ROST and the groundwater analyses evaluated the potential presence of LNAPL and dissolved phase constituents, respectively, in this portion of Hartford. Subsequent activities consisted of soil borings for the installation of the piezometers along with geotechnical analysis of soil samples. The shallow (water table) piezometers were installed with approximately 15 feet of screen. The deeper piezometers have screen lengths of approximately five feet. The deeper screened zones were from approximately 61 to 73 and 91 to 103 feet bgs. At each deeper location, it was the intent to place the screen within the more permeable zones of the Main Sand based on field data contained in the CPT and soil boring logs. Groundwater gauging was subsequently conducted in order to determine horizontal hydraulic gradient and flow directions of groundwater.

4.4 GROUNDWATER GAUGING

In light of numerous influences on groundwater flow in the Hartford area, such as pumping, the groundwater flow is evaluated on an area wide basis. Groundwater gauging events have been conducted on a monthly basis from October 2004 through October 2005 in Hartford and on the adjoining Shell and Premcor properties.

The well gauging events were conducted to measure groundwater depths and apparent LNAPL thickness (if present) in order to determine groundwater flow directions. Temporal variability (including precipitation events, Mississippi River-stage height, atmospheric pressure, and groundwater pumping) influences the groundwater elevations on a daily basis in the monitoring wells. The Mississippi River stage is surveyed quarterly at the Premcor Facility River Dock with previous monthly gauging events using stage data measured at the Mel Price Tailwater (TW), Alton, Illinois gauging station (US Army Corps of Engineers, 2005).

4.5 IN-SITU HYDRAULIC CONDUCTIVITY TESTING

In-situ hydraulic conductivity testing was conducted within the shallower strata overlying the Main Sand as proposed in the May 24, 2005 Work Plan (Clayton 2005a). The testing was conducted to estimate the hydraulic conductivity of the formation near the well and thereby provide hydraulic conductivity ranges for the saturated units. This consisted of instantaneous head aquifer testing (slug testing) wells within the Rand and EPA Strata using a PVC slug of known volume. No conductivity testing was performed in the North Olive Stratum because groundwater in this stratum only occurs as isolated areas of perched water, often consisting of less than one linear foot of water, on the surface of the underlying B Clay Stratum. The selected wells in the Rand Stratum were chosen from areas that were both (1) historically free of LNAPL, (2) typically contained sufficient water to conduct the test and (3) were within the continuously saturated portion of the stratum. Available wells in the EPA Stratum, which were limited in number, were chosen from areas that (1) also have historically been free of LNAPL and (2) were of recent construction.

The wells selected in the Rand Stratum for slug testing were HMW-4 and HMW-50A and the wells in the EPA Stratum were HMW-49C and HMW-50B (Figure 2-2). The testing was conducted on July 27 and July 28, 2005. The boring logs and well construction reports indicate the water-bearing unit screened by the wells in the Rand Stratum is confined at these locations as indicated by the presence of the potentiometric surface at a level above the bottom of the overlying B Clay Stratum. The saturated zone is confined at the two wells screened in the EPA Stratum as indicated by the presence of the potentiometric surface at a level above the bottom of the overlying confining C Clay Stratum (see boring logs and well construction reports in Appendix A).

The data obtained from the hydraulic conductivity tests was downloaded into an electronic database to allow application of regression techniques for computation of hydraulic conductivities. The data were evaluated based on the hydrogeologic conditions present. The data analysis and graphic interpretations were conducted using the Aquifer$^{WIN32®}$ software package developed by Environmental Simulations, Inc. Data sheets and Aquifer$^{WIN32®}$ graphs for the individual wells, along with the boring logs and well construction reports, are provided in Appendix F. Additional hydraulic conductivity testing details were provided in SOP 230 previously presented by Clayton (2004a). Any necessary modifications to the SOP, due to field conditions, are described in the results section.

4.6 LEAD CONCENTRATIONS IN SENTINEL WELLS

As discussed in the May 24, 2005 Work Plan (Clayton 2005a), groundwater sampling of the sentinel wells, located in the Main Sand, has indicated the sporadic presence of lead concentrations above the Class I standard for lead (35 IAC 620.410 Class I Groundwater Quality Standards). More data was considered necessary before a better evaluation of the sporadic lead concentrations could be made, though the results are believed to be attributable to ambient groundwater conditions in the Main Sand.

5.0 GROUNDWATER INVESTIGATION RESULTS

5.1 DIRECT PUSH MULTI-LEVEL GROUNDWATER INVESTIGATION RESULTS

5.1.1 CPT Results

The geology of the north Hartford area, which consists of alluvial deposits of clay and silt overlying the areally extensive Main Sand, has been described in Section 2.0. The CPT results are consistent with these conditions. Saturated zones were identified within the alluvial material overlying the Main Sand at only four locations. The Main Sand extended to boring terminations, due to refusal, ranging from approximately 50 (HROST-98) to 86 feet (HROST-87 and 104) bgs. CPT logs are presented in Appendix B.

5.1.2 ROST™ Results

The ROST identifies LNAPL, which may or may not be of sufficient saturation and volume to flow into a well. ROST-identified LNAPL, which is not of sufficient saturation and volume to flow into a well, is termed residual LNAPL in this report. The ROST investigation defined the extent of residual LNAPL and aided in the identification of areas where free product may be present. This, in turn, was used in the planning of the dissolved phase groundwater investigation helping to understand potential dissolved phase distribution.

The majority of the LNAPL resides in the Main Sand underneath the northern portion of the Site. LNAPL also resides to a lesser degree in the more permeable strata above the Main Sand, including the North Olive, Rand and EPA Strata. Figure 4-1 shows the ROST boring locations and Table 5-1 presents the ROST responses, which are also shown in Figure 5-1 through Figure 5-5. A discussion of the ROST findings and the ROST logs are provided in Appendix C.

The majority of the LNAPL in the Main Sand beneath the northern portion of Hartford has been identified as gasoline range organics (GROs), except in the northern and easternmost portions, which contain mixtures of GROs and diesel range organics (DROs). The LNAPL in both the EPA and Rand Strata consists predominantly of DROs, though there are mixtures containing smaller amounts of GROs in the EPA Stratum.

5.1.3 Discrete Groundwater Sampling Analytical Results

Clayton collected a total of 133 groundwater samples (including 14 duplicate samples) from 39 locations at and adjacent to the Site for this investigation. As stated above, the hydropunch, discrete groundwater sampling is a screening technique and the results can only be used for order of magnitude comparisons. The majority of these groundwater samples (127) were obtained from the Main Sand because the investigation did not indicate the presence of any shallower saturated strata with the following exceptions. Groundwater samples were obtained from the EPA Stratum at three borings in the northern portion of Hartford with two (HROST-84 and 118) north of Rand Avenue and one (HROST-91) at the southeast corner of the intersection of Rand Avenue and North Olive Street. In addition, a groundwater sample was obtained from the Rand Stratum at a location west of Illinois Route 3 (HROST-94) and also at a location (HROST-91) at the southeast corner of the intersection of Rand Avenue and North Olive Street. The groundwater analytical results are provided in Table 5-2. Figure 5-6 presents the total BETX and MTBE results. The groundwater results were compared with Illinois Class I Groundwater Quality Standards (35 IAC 620) or, if not available, Illinois Groundwater Remediation Objectives for Class I Groundwater (35 IAC 742) for comparison purposes only and thus will be referred to as "comparison values" throughout this report. The 35 IAC 620 and 35 IAC 742 values are not established remediation objectives or cleanup values for the Hartford Area Hydrocarbon Plume Site and are referenced for comparison purposes only and thus will be referred to as "comparison values" throughout this report.

The Main Sand discrete groundwater grab sample results indicated BETX concentrations that ranged from undetected to approximately 47,000 micrograms per liter (µg/L) (HROST-13). The two Rand Stratum samples indicated either no detectable BETX or MTBE (HROST-94), or a total BETX concentration of 316 µg/L, though no MTBE was detected (HROST-91). The EPA Stratum samples had BETX concentrations ranging from approximately 1 to 19,000 µg/L (HROST-118), while the MTBE concentrations ranged from <1 to approximately 590 mg/L (HROST-118).

Ten boring locations within the Main Sand with no detectable BETX or MTBE concentrations were located south of the identified LNAPL at the Site (HP-1, HP-3 thru HP-9, HROST-110 and HROST-111).

These ten borings are located within an area bounded approximately by Hawthorne Street to the north and West 4th Street to the south. One additional boring location (HP-2) in this area indicated a single estimated concentration of MTBE that has been attributed to inadequate field decontamination (Clayton 2005b). In addition, the identification of an estimated concentration does not establish a definitive presence of any parameter in a sample. Only values above the reporting limit can be considered to establish the presence of a particular parameter.

Seven other borings located along the southwest and west side of the LNAPL (HROST-97, 98, 101, 103, 104, 109, and 124) only indicated estimated concentrations of BETX or MTBE compounds. These borings extended from West Maple Street on the south to approximately West Cherry Street on the north. The results indicate that the dissolved phase plume associated with the LNAPL in northern Hartford is confined to northern Hartford.

Three borings (HROST-60, 106 and 107) abutting or within the ROST-identified southern LNAPL extent, just south of Watkins Street, indicated BETX concentrations (although HROST-107 is a "J" value, and thus, not a confirmed presence of BETX). Two of the three concentrations were obtained at depths of 40 feet bgs or less while the concentration from HROST-106 was obtained from approximately 65 feet bgs. None of the detected concentrations exceeded groundwater comparison values.

The remaining eleven boring locations (HROST-1, 13, 81, 84, 89, 91, 92, 93, 94, 96, and 118) north of Cherry Street, adjacent to and beyond the western and northern Site borders, all indicated concentrations of BETX at varying depths. The majority of these concentrations did not exceed their applicable comparison value. The BETX concentrations detected in the uppermost Main Sand groundwater from this area ranged from estimated concentrations (J-values) to approximately 47,000 µg/L (HROST-13).

Sample locations within the boundary of the LNAPL are likely to be above comparison values, hence are not summarized herein. The remaining Main Sand samples, with one or more results above a groundwater comparison value, are along the western Site boundary north of Cherry Street. Other results above groundwater comparison values are also found north of Rand Avenue. These findings (dissolved phase plume extending downgradient of the LNAPL) are consistent with the generalized groundwater flow direction in the Main Sand north-northwest, as shown in Figure 2-7. These areas are discussed in further detail below.

Figure 5-7 presents the results that are above a groundwater comparison value in the Main Sand (unless otherwise indicated). Six of these locations (HROST-1, 89, 92, 93, 94 and 96) beyond the LNAPL and along the western border of the Site (south of Rand Avenue) indicate the presence of benzene above its groundwater comparison value of 5 µg/L. The benzene concentrations range from 19 to 3,190 µg/L. These benzene concentrations are detected over a span ranging from approximately 369 to 400 feet MSL with the majority above 380 feet MSL.

The Main Sand groundwater grab sample results north of Rand Avenue indicate benzene concentrations ranging from approximately 60 to 1,540 µg/L (HROST-81, 84 and 118). An ethylbenzene concentration of 1,020 µg/L, which is above its comparison value (700 µg/L) was found in this area (HROST-118). MTBE concentrations above its comparison value (70 µg/L) are also found at two locations north of Rand Avenue (HROST-81 and 84) at levels ranging from approximately 70 to 125 µg/L. The highest concentrations of MTBE have been detected north of Rand Avenue in the EPA Stratum. The MTBE results in the two EPA Stratum groundwater grab samples (HROST-84 and 118) range from approximately 83 to 590 µg/L.

Dissolved phase petroleum indicators, specifically BETX, were detected along South Olive Street (HROST-57, 119, 120 and 121), though no MTBE was identified. Overall, only five of the total of thirteen samples collected from these four borings indicated the presence of BETX. The BETX identifications also occurred at varying depths within the Main Sand ranging from 31 feet bgs to 70 feet bgs, though three of the five occurred at depths of 56 feet bgs or greater. None of the detected compounds were above groundwater comparison values, with two exceptions. Benzene was detected at a concentration (128 µg/L) exceeding the comparison value at 70 feet bgs near the intersection of East 2nd and South Olive Streets (HROST-119). Benzene was also detected at a concentration of 14 µg/L near the intersection of East 1st and South Olive Streets (HROST-57) at approximately 35 feet bgs. However, based on all of the findings to date, including established northerly groundwater flow patterns in Hartford and results of discrete groundwater grab sampling from three borings (no detectable constituents at either HROST-110 and HROST-111 and no concentrations above comparison values at HROST-112) all located north of Hawthorne Street, there is no evidence that the identified BETX concentrations in

HROST-57 and HROST-119 through 121 are associated with the known LNAPL at the Site. The results from HROST-57 and HROST-119 potentially indicate contribution from other sources unrelated to the Site.

5.2 MONITORING WELL GROUNDWATER SAMPLING RESULTS 2003-2005

Since commencement of quarterly groundwater sampling in December 2003 and continuing through October 2005, a total of 106 different wells have been monitored. The inclusive data set currently consists of 62 wells in the Main Sand, ten wells in the EPA Stratum, 30 wells in the Rand Stratum, and four wells in the North Olive Stratum.

The Main Sand wells are primarily located along and west of North Olive Street, south of Rand Avenue, north of East 1st Street, and along and east of Illinois State Route 3 (Figure 5-8). One well (HMW-49) is located beyond this extent, north of Rand Avenue along North Delmar Avenue, and one well (HMW-50) is located at the northwest portion of the Tannery Property. The Main Sand wells were sampled up to 13 times.

The smaller data set for the EPA Stratum is due to its limited lateral presence in Hartford. The EPA Stratum wells are primarily located in the north and northeast portions of Hartford (Figure 5-9). One well (HMW-49) is located beyond this extent, north of Rand Avenue along North Delmar Avenue, and one well (HMW-50) is located at the northwest portion of the Tannery Property. The EPA Stratum wells were sampled up to six times.

The Rand Stratum wells are located within the northern, central and northeastern portions of Hartford (Figure 5-10), due to the limited lateral presence of the Rand Stratum in Hartford. One well (HMW-50) is located at the northwest portion of the Tannery Property. The Rand Stratum wells were sampled up to five times.

The small data set for the North Olive Stratum is due to the limited presence of water in the stratum. The North Olive Stratum wells are located adjacent to Old St. Louis and Alton Road, and in the northern portion of Hartford (Figure 5-11). The North Olive Stratum wells were sampled up to three times.

A review of all groundwater analytical results for the 106 monitoring wells sampled from December 2003 through October 2005 indicated the presence of various constituents (see Tables 5-3 through 5-6). Figures 5-8 through 5-11 present summaries of results of the primary LNAPL indicator parameters (including total BETX, total SVOCs, MTBE and lead) for each of the four groundwater strata. The analytical results are discussed in the following sections. MTBE has not been associated with the LNAPL in northern Hartford based on product characterization data.

5.2.1 BETX Analytical Results Summary

The Main Sand groundwater sample data set indicated BETX concentrations that ranged from not detected to approximately 103 milligrams per liter (mg/L). BETX constituents were not detected in samples from 11 wells (HMW-26, HMW-27, HMW-28, HMW-39B, MP-52B, MP-61A, MP-62A, MP-65C, MP-66C, MP-67C, and MP-81C). These locations are primarily located south of the interpreted extent of the ROST response, although HMW-39B is located on the west edge of the ROST response extent. Samples with no detectable concentrations of BETX were also observed on occasion at six wells (HMW-39C, HMW-40C, HMW-41C, HMW-51C, HMW-52C, and MP-61C). In January 2005, sentinel wells HMW-25 and HMW-29 indicated BETX constituents (Clayton 2005b) that resulted from inadequate decontamination procedures during sampling. Subsequent sampling indicated no detections of BETX constituents at these wells. Therefore, these results were not presented in Figure 5-8.

The Main Sand groundwater sample data set indicated the highest concentrations of BETX were primarily located within the interpreted extent of the free product plume, with 18 wells exhibiting concentrations in samples above comparison values (Figure 5-8). In addition, concentrations of BETX in samples were above comparison values in 12 Main Sand wells located west and south of the interpreted free product plume, within the interpreted extent of the ROST Response. The highest concentration of BETX in samples was located at well MP-59C, located along North Market Street, between East Forest and East Watkins Streets. The dissolved constituents above comparison values to the south and portions of the west are largely limited to areas of residual LNAPL (which has been reasonably defined with the ROST), with concentrations rapidly falling off beyond the area of residual LNAPL.

The EPA Stratum groundwater sample data set indicated BETX concentrations that ranged from not detected to approximately 26 mg/L. Samples at one location (HMW-47B) located just south of West

Rand Avenue and west of North Delmar Avenue contained no detectable concentrations of BETX. The highest concentrations of BETX were detected in samples at two wells (MP-85C and HB-33) located along North Olive Street in the vicinity of and just south of East Birch Street, and at one well (HMW-49C) located on North Delmar Avenue, north of West Rand Avenue. The concentrations of BETX in samples at these three EPA Stratum wells were above comparison values.

The Rand Stratum groundwater sample data set indicated BETX concentrations that ranged from not detected to approximately 75 mg/L. No detectable concentrations of BETX were observed in samples at one well (MP-85B) located at North Olive and East Birch Streets. Samples with no detectable concentrations of BETX were also observed on occasion at one well (HMW-50A) located at the northwest portion of the Tannery Property and at one well (HMW-1) located in the vicinity of North Olive Street between East Date and East Cherry Streets. The highest concentrations of BETX in samples collected from Rand Stratum wells (having concentrations above comparison values) were located along the southwest edge of the Rand Stratum (MP-49B, MP-52B and MP-56B), along and on either side of Cherry Street (MP-30B, MP-36B, MP-37B, and MP-42B) and at the northeast corner of the Village (HMW-48B).

The North Olive Stratum groundwater sample data set indicated BETX concentrations that ranged from not detected to approximately 40 mg/L. Samples with no detectable concentrations of BETX were observed at HMW-47A, located south of West Rand Avenue and west of West Delmar Avenue and MP-31B, located on West Cherry Street near Old St. Louis and Alton Road. Detected BETX concentrations in samples ranging from approximately 24 mg/L to 40 mg/L were detected at wells MP-83A and HMW-48A, respectively. Well MP-83A is located just north of MP-31B. Well HMW-48A is located on North Olive Street, just south of Rand Avenue. The detected concentrations in samples from these two North Olive Stratum wells were above comparison values.

5.2.2 SVOCs Analytical Results Summary

The Main Sand groundwater sample data set indicated total SVOCs concentrations that ranged from not detected to approximately 4.7 mg/L. No detectable concentrations of SVOCs in samples were found in 20 wells located south and west of the interpreted extent of the free product plume. In addition, SVOCs were occasionally not detected in samples at well HB-32 located within the free product plume, along

North Market Street, between East Birch and East Cherry Streets. SVOCs were detected in samples from wells located primarily within and adjacent to the free product plume. SVOCs, which were above comparison values in 29 of the Main Sand wells, included bis (2-ethylhexyl)phthalate, o-cresol, 2,4-dimethylphenol, phenol, and naphthalene. The concentration of SVOCs decreased with increasing distance from the southern boundary of the free product plume. As with BETX, the total SVOC concentrations rapidly decrease beyond the area of residual LNAPL.

The EPA Stratum groundwater sample data set indicated total SVOCs concentrations that ranged from not detected to 0.48 mg/L. SVOCs were not detected in samples from one well (HMW-50B, sampled five times) located at the northwest portion of the Tannery Property. The detected SVOCs in samples were found in three wells (HMW-3, MP-85C, and HB-33) located along North Olive Street between East Rand Avenue and East Cherry Street, and in two wells (HMW-49B and HMW-49C) located on North Delmar Avenue, north of West Rand Avenue. SVOCs that were above comparison values in samples from five of the EPA Stratum wells included bis (2-ethylhexyl)phthalate, benzo(a)anthracene, benzo(b)fluoranthene, benzo(f)fluoranthene, chrysene, and naphthalene.

The Rand Stratum groundwater sample data set indicated total SVOCs concentrations that ranged from not detected to 0.68 mg/L. SVOCs were not detected in samples from two wells, one (HMW-1) located off North Olive Street between East Cherry and East Data Streets, and one (MP-80B) located near North Delmar Avenue and West Birch Avenue. In addition, samples with no detectable concentrations of SVOCs were observed on occasion in samples from well HMW-50B, located at the northwest portion of the Tannery Property. SVOCs that were above comparison values in samples from nine of the Rand Stratum wells included bis (2-ethylhexyl)phthalate, benzo(a)anthracene, benzo(b)fluoranthene, chrysene, and naphthalene.

The North Olive Stratum groundwater sample data set indicated SVOCs were detected in both wells analyzed: HMW-48A located on North Olive Street south of East Rand Avenue, and MP-31B located at the west end of West Cherry Street. The total SVOCs concentrations in samples ranged from not detectable to 0.70 mg/L. SVOCs that were above comparison values in samples at North Olive Stratum well HMW-48A included bis (2-ethylhexyl)phthalate and naphthalene.

5.2.3 MTBE Analytical Results Summary

MTBE was detected in samples from nine of the 62 Main Sand wells at concentrations up to approximately 0.104 mg/L. The detected MTBE was found in samples from two wells (MP-30C and MP-40C) located within the central portion of the free product plume, two wells (HMW-46C and HMW-47C) along and one well (HMW-38C) adjacent to the northern interpreted extent of the free product plume, one well (HMW-49D) north of the free product plume, one well (MP-85D) adjacent to the east interpreted extent of the free product plume, and one well (HMW-50C) located at the northwest portion of the Tannery Property. MTBE was reported in a sample at an estimated concentration below its reporting limit in sentinel well HMW-26 during the October 2005 sampling event. However, the identification of an estimated concentration does not establish a definitive presence of any parameter in the sample. Only values above the reporting limit can be considered to establish the presence of a particular parameter. The detected concentration of MTBE in samples was above its comparison value in well MP-85D during two of three sampling events and in well HMW-47C during its only sampling event.

MTBE was detected in samples from two of the ten EPA Stratum wells, at concentrations up to approximately 0.243 mg/L. The detected MTBE in samples was found in HMW-49C, located along North Delmar Avenue, north of West Rand Avenue, and HB-33, located along North Olive Street, between East Birch and East Cherry Streets. The detected concentrations of MTBE in samples from wells HMW-49C and HB-33 were above its comparison value.

MTBE was detected in samples from three of the 30 Rand Stratum wells, at concentrations up to 0.0634 mg/L. The detected MTBE in samples was reported in Rand Stratum wells HMW-45B and MP-39B located west of North Delmar Avenue and along West Arbor Street, and between West Cherry and West Date Streets, respectively. In addition, MTBE was reported at an estimated concentration in a sample below its reporting limit in well HMW-4 (located on North Olive Street between East Rand Avenue and East Birch Street) during one sampling event. As stated above, a value below a detection limit cannot be considered definitive. None of the detected MTBE concentrations in samples from the Rand Stratum wells were above its comparison value.

MTBE was not detected in any of the groundwater samples collected from the four wells sampled in the North Olive Stratum.

In general, the presence of MTBE was sporadic and concentrations decreased with increasing depth. Furthermore, MTBE has not been associated with the LNAPL at the Site based on product characterization data.

5.2.4 Lead Analytical Results Summary

The Main Sand groundwater sample data set indicated that 38 wells contained total lead and nine wells contained dissolved lead at concentrations that were above its comparison value. Total lead concentrations in samples ranged up to 0.204 mg/L and dissolved lead concentrations ranged up to 0.0228 mg/L. The groundwater samples from wells where total and dissolved lead were detected at elevated concentrations are located within and adjacent to the free product plume and throughout each stratum.

The EPA Stratum groundwater sample data set indicated that seven wells contained total lead and two wells contained dissolved lead at concentrations that were above its comparison value. Total lead concentrations in samples ranged up to 0.0864 mg/L and dissolved lead concentrations ranged up to 0.0097 mg/L.

The Rand Stratum groundwater sample data set indicated that 22 wells contained total lead and three wells contained dissolved lead at concentrations that were above its comparison value. Total lead concentrations in samples ranged up to 0.84 mg/L and dissolved lead concentrations ranged up to 0.0879 mg/L.

The North Olive Stratum groundwater sample data set indicated three wells contained total lead and one well contained dissolved lead at concentrations that were above its comparison value. Total lead concentrations in samples ranged up to 0.0478 mg/L and dissolved lead concentrations ranged up to 0.0306 mg/L.

5.3 PIEZOMETER INSTALLATION NEAR HARTFORD MUNICIPAL SUPPLY WELLS RESULTS

As discussed in Section 4.3, Clayton (2005c) previously presented the piezometer installations findings.

The findings of the investigation are generally consistent with the previously identified geology in the area, specifically, the presence of alluvial deposits of silt and clay overlying sand. The North Olive, Rand and EPA Strata were not identified within the alluvial material overlying the sand in this area (generally south of Watkins Street). The ROST™ screening indicated that no petroleum hydrocarbons were present at the nine piezometer locations. As discussed above in Section 5.1, no quantifiable concentrations of BETX or MTBE were identified in the analytical results of the vertically discrete groundwater grab samples from the Main Sand at the nine piezometer locations. A summary of the groundwater analytical results is also provided in Figure 5-6.

5.4 IN-SITU HYDRAULIC CONDUCTIVITY TESTING RESULTS

The average hydraulic conductivity for the Rand Stratum wells (HMW-4 and HMW-50A) was 4.2E-03 centimeters per second (cm/s) with a geometric mean of 1.9E-03 cm/sec. The average hydraulic conductivity and geometric mean for the EPA Stratum wells (HMW-49C and HMW-50B) was 2.0E-04 cm/sec and 7.6E-05 cm/sec, respectively. A summary of the data and the calculated hydraulic conductivities is provided in Table 5-7. Table 5-8 summarizes data from previous conductivity testing conducted in the identified strata in Hartford, including limited testing of the clay strata. The summary includes data from in-situ slug tests and laboratory permeability analyses.

Average and geometric mean hydraulic conductivity values for the Main Sand are listed in Table 5-8. The North Olive Stratum hydraulic conductivity ranged from 1.4E-06 to 2.9E-04 cm/sec (8.9E-05 cm/sec average) in the area of the Hartford Community Center. At this same location, the hydraulic conductivity of the clay strata ranged from 1.7E-04 to 6.0E-09 cm/sec (5.7E-05 cm/sec average). The Rand Stratum hydraulic conductivity ranged from 5.5E-05 to 7.9E-03 cm/sec (2.8E-03 cm/sec average). In the northeastern portion of Hartford, the hydraulic conductivity of the EPA Stratum ranged from 1.5E-05 to 3.8E-04 cm/sec (2.0E-04 cm/sec average). The hydraulic conductivity for the unconfined Main Sand in the central portion of Hartford ranged from 1.6E-02 to 3.1E-02 cm/sec (2.2E-02 cm/sec average). Pump tests performed at the Premcor Facility suggest the hydraulic conductivity of the Main Sand is on the order of 1.0E-01 to 1.0E-02 cm/sec (Clayton 2005a).

Based on the permeability testing and slug tests, the average hydraulic conductivity values differ by two orders of magnitude between the North Olive and Rand Strata, though there appears to be no significant difference between the North Olive Stratum and the clay strata. However, hydraulic conductivity data derived from slug testing provides results that can vary within one order of magnitude. Furthermore, the hydraulic conductivity analyses of these strata are limited in both number and extent. As expected, there is a significant difference between the Main Sand average hydraulic conductivity results and those of the overlying strata. The difference between the Main Sand and the overlying alluvial silts and clays ranges from one to three orders of magnitude.

5.5 GROUNDWATER GAUGING/FLOW MAPPING RESULTS

Groundwater within the North Olive Stratum, which is potentially seasonal or more ephemeral, occurs as isolated areas of perched water on the surface of the underlying B Clay Stratum in Hartford. The data do not indicate any significant areas of continually perched water in this stratum. During the October 2005 well gauging event only 19 of the 76 monitoring wells had a water level that was above the top of the B Clay Stratum underlying the North Olive Stratum. Since no groundwater flow was interpreted to be present, no generalized groundwater flow map was created for this stratum; rather, the groundwater map created for the North Olive Stratum presents only the elevation data and saturated thickness where applicable (Figure 5-12). The groundwater gauging results for October 2005 are presented in Table 5-9.

Groundwater in the Rand Stratum appears to be confined northeast of Hartford at the Shell Rand Avenue site, though this is the only area where the Rand Stratum was completely saturated. A generalized groundwater flow direction map of the Rand Stratum indicates the presence of a groundwater divide, located northeast of the Site, trending along a general northwest/southeast axis (Figure 2-8). Groundwater on the northern side of the divide flows in a northeasterly direction and flow on the southern side of the divide is in a southwesterly direction. The southwesterly flow gradient ranged from 0.0178 to 0.0305 during 2005. The October 2005 groundwater flow map for the Rand Stratum is presented in Figure 5-13. In general, groundwater in the Rand Stratum, south of Rand Avenue, is also considered to represent localized areas of perched water on the surface of the underlying C Clay Strata. Since no groundwater flow was interpreted to be present in this southern area, it was not contoured in Figure 5-13.

Groundwater in the EPA Stratum was confined and hydraulically connected to the Main Sand in northeastern Hartford, on the Shell Tannery Property, the Shell Rand Avenue Site, and the Premcor facility. The generalized groundwater flow direction map of the EPA Stratum also indicates the presence of a groundwater divide, located northeast of the Site, trending along a general northwest/southeast axis (Figure 2-9). Groundwater on the northern side of the divide flows in a northeasterly direction while flow on the southern side of the divide is in a southwesterly direction. However, as the southwesterly flow reaches beyond the extent of the D Clay Stratum, it then flows northwestward within the Main Sand because these strata are hydraulically connected (Figure 2-7). The southwesterly flow gradient was calculated as ranging from 0.0014 (August) to 0.0607 (January) during 2005 (Table 5-10). The October 2005 groundwater flow map for the EPA Stratum is presented in Figure 5-14.

The October 2005 groundwater flow map of the Main Sand indicates a groundwater flow trend that is northwesterly within Hartford (Figure 5-15). The northwesterly flow gradient was calculated as averaging 0.0017 in October 2005 (Table 5-10). The general northwesterly flow gradient has ranged from 0.0006 to 0.0029 during 2005 (Table 5-10). This overall northerly groundwater flow direction is consistent with historical interpretations and the operation of the pumping centers in the Hartford vicinity (Hartford, Roxana and Wood River). As stated previously, the combined pumping rate at these pumping centers is greater than 10,000 GPM. Flow in the Main Sand along the eastern portion of the Village has also been altered locally by pumping on the Premcor property.

Vertical hydraulic gradients for July through October 2005 at the HP-Series well nests (HP-1, HP-3, HP-4, and HP-5) are summarized in Table 5-11. Based on a review of Table 5-11, the vertical gradients between the shallow and intermediate Main Sand wells ranged from 0 (horizontal) to 0.0038 feet/feet with approximately half of the gradients being downward. The vertical gradients between the intermediate and deep Main Sand wells ranged from 0.0003 to 0.0030 feet/feet with the majority of the gradients being upward. In general, the groundwater flow in this area of the Main Sand is relatively horizontal.

Transducer locations within Hartford are presented in Table 5-12 and on Figure 5-16. Graphs presenting transducer results, river stage and barometric pressure are included in the Graphs Section.

5.6 LEAD CONCENTRATIONS IN SENTINEL WELLS EVALUATION RESULTS

As of October 2005, a total of eight sentinel well monitoring events have been completed. In 2004, detected lead concentrations above its comparison value (Class I Groundwater Quality Standard –

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0.0075 mg/L) ranged from 0.0076 (HMW-28 in April 2004) to 0.0238 (HMW-29 in April 2004) mg/L. All sentinel wells, with the exception of HMW-25 and HMW-27, indicated one or more lead concentrations above its comparison value since sentinel well monitoring began in December 2003. HMW-26 and HMW-28 had only one lead concentration above its comparison value (December 2003 and April 2004, respectively), while HMW-29 had two lead concentrations above its comparison value (April and October 2004). However, the four quarterly monitoring events conducted in 2005, from January through October, did not indicate any total lead concentrations above its comparison value. To date, no dissolved phase, petroleum-related volatile or semi-volatile organic compounds attributed to the LNAPL in northern Hartford have been identified in any of the 2003 through 2005 sentinel well results. The occurrence of lead in groundwater samples collected from the sentinel wells is intermittent and does not show any apparent pattern, and does not appear to be associated with petroleum hydrocarbons.

6.0 CONTINUED GROUNDWATER MONITORING

Additional activities will be required to address the dissolved phase groundwater plume. These activities will include identifying the potential receptors of the plume, improving the understanding of flow and transport downgradient of the Site, and continuing the evaluation of the natural attenuation of the plume. The additional activities are expected to include the use of groundwater modeling and completion of any additional data gathering necessary for the modeling. These activities will need to be conducted to determine what remedial measures may be necessary concerning the dissolved phase groundwater plume. In the interim, groundwater monitoring will be continued. Monitoring will include both groundwater flow monitoring and groundwater quality monitoring. To verify the groundwater flow in the area of the Hartford water supply wells and also in the deeper Main Sand aquifer, additional piezometers and additional monitoring wells will be installed. The additional monitoring wells will also be used to enhance delineation, both horizontally and vertically, of the dissolved phase plume. The installation of the additional piezometers and monitoring wells is discussed in Section 6.1. The continued well gauging and sampling is discussed in Section 6.2. Additional activities are discussed in Section 6.3.

6.1 PIEZOMETER AND MONITORING WELL INSTALLATION

6.1.1 Piezometer Locations

Additional piezometer locations were determined on the basis of groundwater hydropunch results which indicated the presence of dissolved phase, petroleum-related (BETX) constituents above groundwater comparison values in the Main Sand Stratum, at a depth of approximately 70 feet bgs on South Olive Street (HROST-119) and at a depth of approximately 34 feet bgs on South Olive Street (HROST-57). Both HROST-57 and HROST-119 are considered to be upgradient of, and unrelated to, the LNAPL at the Site. This is based on groundwater flow patterns (generally to the north – northeast in this area) and the absence of BETX constituents in groundwater samples collected between HROST-119 and the LNAPL in northern Hartford at HROST-110 and HROST-111 (located between East Maple and East Hawthorne Streets). While BETX was detected in one of the groundwater screening samples collected at HROST-112 (which is located due east of HROST-111), no benzene was detected at this location and the total BETX concentration at HROST-112 (20.7 µg/L) is two orders of magnitude less than the total BETX concentration at HROST-119 (1,301 µg/L). Furthermore, sentinel well HMW-29, which is located approximately 270 feet to the west-southwest of HROST-57, is screened over the same interval sampled at HROST-57 and no detectable BETX concentrations associated with the LNAPL have been identified there since groundwater sampling began in December 2003.

To better understand the groundwater flow, in the vicinity of HROST-57 and HROST-119, nested piezometers (HP-10A and HP-10B) are proposed to be installed on East Second Street (see Figure 6-1). In this area, the nested piezometers will help improve the understanding of vertical flow between the shallow and deep Main Sand, as well as general flow within the deep Main Sand. In addition, these wells will help improve the understanding of the apparent groundwater divide created in the east central portion of Hartford by pumping on the Premcor facility (see Section 5.5). HP-10A will be installed to straddle the water table with a screen interval from approximately 25 to 40 feet bgs and HP-10B will be installed to screen the deeper portion of the Main Sand from approximately 65 to 70 feet bgs.

6.1.2 Monitoring Well Locations

Groundwater screening has also indicated the presence of dissolved phase, petroleum-related (BETX) constituents above groundwater comparison values in the Main Sand Stratum, at depth, along the leading edge of the dissolved phase plume to the northwest. As indicated above, additional activities will be required to address this portion of the dissolved phase groundwater plume. To enable a more complete understanding of potential groundwater impacts, especially at depth within the Main Sand, two new well nests (HMW-55 and HMW-56) are proposed to be installed along the levee and Illinois Route 3 corridor, west of West Arbor and West Cherry Streets, respectively (see Figure 6-1). At these locations, a monitoring well will be placed in each interpreted permeable strata. Only the Rand Stratum and the Main Sand are expected to be encountered at HMW-55. Therefore, at HMW-55, it is anticipated that the Rand Stratum will be screened from approximately 16 to 20 feet bgs and the Main Sand will be screened at 3 discrete depths. At HMW-56, the North Olive Stratum, the Rand Stratum, and the Main Sand are expected to be encountered. Therefore at HMW-56, it is anticipated that the North Olive Stratum will be screened from approximately 10 to 12 feet bgs, the Rand Stratum will be screened from approximately 15 to 26 feet bgs, and the Main Sand Stratum will be screened at 3 discrete depths.

The three discrete depths within the Main Sand Stratum that will be screened at both HMW-55 and HMW-56 are 1) from approximately 25 to 35 feet bgs (across the water table or up to the base of the overlying confining unit), 2) from approximately 45 to 50 feet bgs (depth at which constituents were detected above comparison values during groundwater screening investigation), and 3) from approximately 65 to 70 feet bgs (approximate greatest depth at which constituents were detected during the groundwater screening investigation).

In order to enhance the spatial distribution of the existing monitoring network to evaluate groundwater flow and the magnitude of groundwater impacts within the deeper portion of the Main Sand in the northeastern portion of Hartford, an additional monitoring well will be installed at existing monitoring well location HMW-48 located on North Olive Street, just south of Rand Avenue (see Figure 6-1). At HMW-48, wells already screen the North Olive, Rand, EPA, and top of the Main Sand Strata. Therefore, an additional deep monitoring well will be installed in the Main Sand and screened from approximately 65 to 70 feet bgs.

6.1.3 Installation Procedures

Both unconfined (water table) and confined (piezometric surface) conditions are anticipated in the Main Sand Aquifer at the proposed locations. The nested piezometers/wells are anticipated to be installed using a conventional hollow-stem auger or rotosonic drill rig. The shallowest piezometer/well in the Main Sand will generally straddle the identified water table or be screened up to the base of the overlying confining unit, depending on conditions at the time of installation. These locations will be nested to enable evaluation of groundwater conditions at depth within the Main Sand along with both horizontal and vertical gradients.

All new piezometers/wells are proposed to be constructed of 2-inch ID polyvinyl chloride (PVC) with 0.010-inch slotted screens. As these piezometer/wells are intended to evaluate groundwater elevation conditions that may vary significantly over the course of the year, the screen length of the shallow piezometer/wells will be approximately 10 to 15 feet to minimize the potential of dry piezometer/wells. Available information indicates the water table may fluctuate up to 10 feet or more in some locations over the course of a year. As the deeper piezometer/wells are intended to provide vertical gradient data, the screen lengths of these will be approximately five feet to minimize the influence of vertical groundwater gradients.

Additional monitoring well installation and development details are provided in SOPs 210 and 212 (Clayton 2004a). These SOPs may be modified based on field conditions. Actual screened depths will be determined in the field after the soil boring logs have been reviewed. The intent is to screen the more permeable zones of the Main Sand.

Each new well will be surveyed by an Illinois-licensed surveyor for horizontal control referenced to Illinois State Plane West Zone NAD 83 (feet) and vertical control referenced to mean sea level (feet). The survey is anticipated to be conducted by CMT of Edwardsville, Illinois. This survey will enhance the unified horizontally and vertically controlled database of existing wells within Hartford.

6.2 PROPOSED MONITORING WELL GAUGING AND SAMPLING

6.2.1 Well Gauging

Groundwater gauging has been conducted in Hartford on a monthly basis in the existing piezometers/wells from September 2004 to October 2005 in order to provide a comprehensive determination of horizontal hydraulic gradients and flow directions of groundwater. The gauging results have indicated relatively constant groundwater flow directions in the identified saturated strata as discussed in Section 2.4 and 5.5. Based on the evaluation of this comprehensive yearlong groundwater mapping database, gauging of the existing monitoring piezometer/well network on a quarterly basis will provide satisfactory data to evaluate groundwater flow directions at the Site. This quarterly gauging schedule started with the October 2005 gauging event and will continue throughout 2006. In addition, the comprehensive groundwater mapping database has shown that continued gauging of the entire network of existing piezometers/wells is not necessary to satisfactorily define the groundwater flow directions at the Site. Therefore, a subset of piezometers/wells (including those newly installed) will be selected for continuation of the quarterly gauging in Hartford. This will be supplemented by data loggers at selected wells that will continuously record water levels (Table 5-12 and Figure 5-16).

6.2.2 Well Sampling

Quarterly groundwater sampling of existing wells within Hartford, that do not contain LNAPL, has been on-going since December 2003. As wells have been installed as part of investigative activities during

2004 and 2005, they have been incorporated into the quarterly monitoring program. To monitor conditions along the perimeter of the dissolved phase plume, a select number of monitoring wells (including newly installed nested wells HMW-55 and HMW-56) will continue to be sampled and analyzed on a quarterly basis (see Table 6-1 and Figure 6-2). To monitor conditions within the dissolved phase plume a select number of monitoring wells (including newly installed HMW-48E) will be sampled and analyzed on an annual basis (see Table 6-1 and Figure 6-2). This will include sampling selected wells screened not only in the Main Sand but also the EPA and Rand Strata.

The samples are proposed to be collected using the low-flow sampling technique in accordance with SOP 415a (Appendix E). The groundwater sampling procedures presented in SOP 415a have been revised to reflect recent U.S. EPA guidance. However, this technique may not be possible at shallow locations with slow recharge to the well (i.e., wells screened in the EPA and Rand). If the low-flow technique cannot be used in these locations, then the peristaltic pump or bailer method will be used as appropriate.

In addition, the evaluation of the comprehensive groundwater analytical database has shown that continued sampling and analysis of the entire network of existing wells (without LNAPL) is not necessary to satisfactorily monitor the groundwater conditions at the Site. Therefore, a subset of wells is proposed to be selected for continuation of the quarterly monitoring in Hartford. In addition, the parameter list is proposed to be modified to consist of benzene, ethylbenzene, toluene and xylenes (BETX), methyl tert-butyl ether (MTBE), metals (total and dissolved) along with general chemistry and natural attenuation parameters. The samples will be analyzed for this modified parameter list of hydrocarbon parameters using the practical quantitation limits (PQLs) and analytical methods presented in Table 6-2. The containers with applicable preservation requirements (if appropriate) for each parameter are presented in Table 6-3. Additional groundwater gauging, monitoring and decontamination details are provided in SOPs 220 and 500 (Clayton 2004a). These SOPs may be modified based on field conditions.

6.3 ADDITIONAL ACTIVITIES

Additional activities will be required to address the dissolved phase groundwater plume. These activities will include identifying the potential receptors of the plume, improving the understanding of flow and transport downgradient of the LNAPL, and continuing the evaluation of the natural attenuation of the plume. Additional activities are expected to include additional dissolved plume characterization and groundwater modeling. These activities will be used in the identification of appropriate remedial measures concerning the dissolved phase groundwater plume.

7.0 CONCLUSIONS

Based on a review of the results of this investigation, the following conclusions are made regarding the dissolved phase hydrocarbon plume at the Site.

The area of the Hartford Municipal Wells has not been impacted by the LNAPL based on the followings points:

- Regional groundwater flow in the Main Sand has consistently been northerly (away from the Hartford municipal wells) based on a review of both historical and recent flow mapping data.
- Sentinel wells have shown no indications of impact from the existing LNAPL and associated dissolved phase hydrocarbon plume since their installation in December 2003.
- The ROST investigation showed no indications of LNAPL in the vicinity of the Hartford municipal wells.
- The groundwater screening investigation in the vicinity of the Hartford municipal wells showed no indications of dissolved phase hydrocarbons.
- Groundwater flow mapping in the vicinity of the Hartford municipal wells does not indicate any pumping influence by the municipal wells beyond the immediate area of their location.
- The daily, short term (8 to 10 hours/day) pumping of the active Hartford municipal well has not, and is not, anticipated to draw either LNAPL or dissolved phase hydrocarbon-impacted groundwater towards the area of the Hartford municipal wells.

Based on current conditions and the long-term existence of the LNAPL and dissolved phase plumes in northern Hartford, it is considered highly unlikely that the Hartford Municipal Wells will be impacted by these plumes.

The extent of the dissolved phase hydrocarbon plume has been defined within the available area of investigation. The following findings are consistent with groundwater flow in the Main Sand which, based on a review of both historical and recent flow mapping data, has consistently been northerly.

- The groundwater screening investigation along the southern boundary of the interpreted extent of the ROST response showed no indications of dissolved phase hydrocarbons.

- The groundwater screening investigation along southern portions of the western boundary of the interpreted extent of the ROST response did not indicate the presence dissolved phase hydrocarbons above applicable groundwater comparison values.

- The groundwater screening investigation and monitoring well groundwater sampling results show that dissolved constituents above comparison values to the south and portions of the west are largely limited to areas of residual LNAPL (which has been reasonably defined with the ROST) with concentrations rapidly falling off beyond the area of residual LNAPL.

- The groundwater screening investigation along northern portions of the western boundary of the interpreted extent of the ROST response indicated the presence of dissolved phase hydrocarbons above applicable groundwater comparison values.

- The groundwater screening investigation along the northern and eastern boundaries of the Site indicated the presence of dissolved phase hydrocarbon concentrations above applicable groundwater comparison values.

- The groundwater screening investigation revealed that the highest concentrations of MTBE are found north of Rand Avenue.

Based on current conditions and the long-term existence of the LNAPL at the Site, the dissolved phase plume is expected to continue to form a narrow "halo" around the southern and the majority of the western portions of the LNAPL with similar dissolved phase conditions anticipated along the remaining LNAPL boundaries.

This report also presents the proposed continued groundwater monitoring to verify the understanding of groundwater flow and to enhance the understanding of the dissolved phase plume. The continued groundwater monitoring will include the following:

- Installation of a nest of piezometers south of the LNAPL, to further assess groundwater flow in the deep Main Sand and potential vertical flow gradients in the relative vicinity of the Hartford Municipal wells. These activities will also enhance the Hartford geological and hydrogeological databases.

- Installation of nested monitoring wells at selected areas bounding the LNAPL to further assess groundwater quality and flow, both horizontally and vertically in northern Hartford. These activities will also enhance the database regarding the geology and hydrogeology underlying Hartford.

- Gauging of selected piezometer/monitoring wells on a quarterly basis, including the new nested piezometers/wells, to monitor groundwater flow in the identified more permeable units (Rand, EPA and Main Sand Strata).

- Groundwater sampling and analyses of selected monitoring wells (without LNAPL) on a quarterly basis, including the new nested wells, to monitor the dissolved phase hydrocarbon plume in Hartford.

8.0 SCHEDULE

Figure 8-1 presents an anticipated schedule for the continued groundwater monitoring. There are three main field activities associated with this monitoring:

1. Installation of piezometers and monitoring wells at selected locations in northern Hartford.
2. Continued quarterly gauging at selected existing and new piezometers and monitoring wells to monitor the groundwater flow within the Main Sand (horizontally and vertically) and other saturated strata (horizontally).
3. Continued quarterly groundwater sampling at selected existing and new monitoring wells that do not contain LNAPL to monitor the groundwater conditions within the Main Sand (horizontally and vertically) and other saturated strata (horizontally).

These activities will be scheduled upon approval of the activities proposed herein by the Agencies. The installation of the additional piezometers and monitoring wells will require obtaining access to areas controlled by others (i.e., Illinois Department of Transportation and the Wood River Levee District). As a result, field activities in these areas will not be able to proceed until these access issues are resolved.

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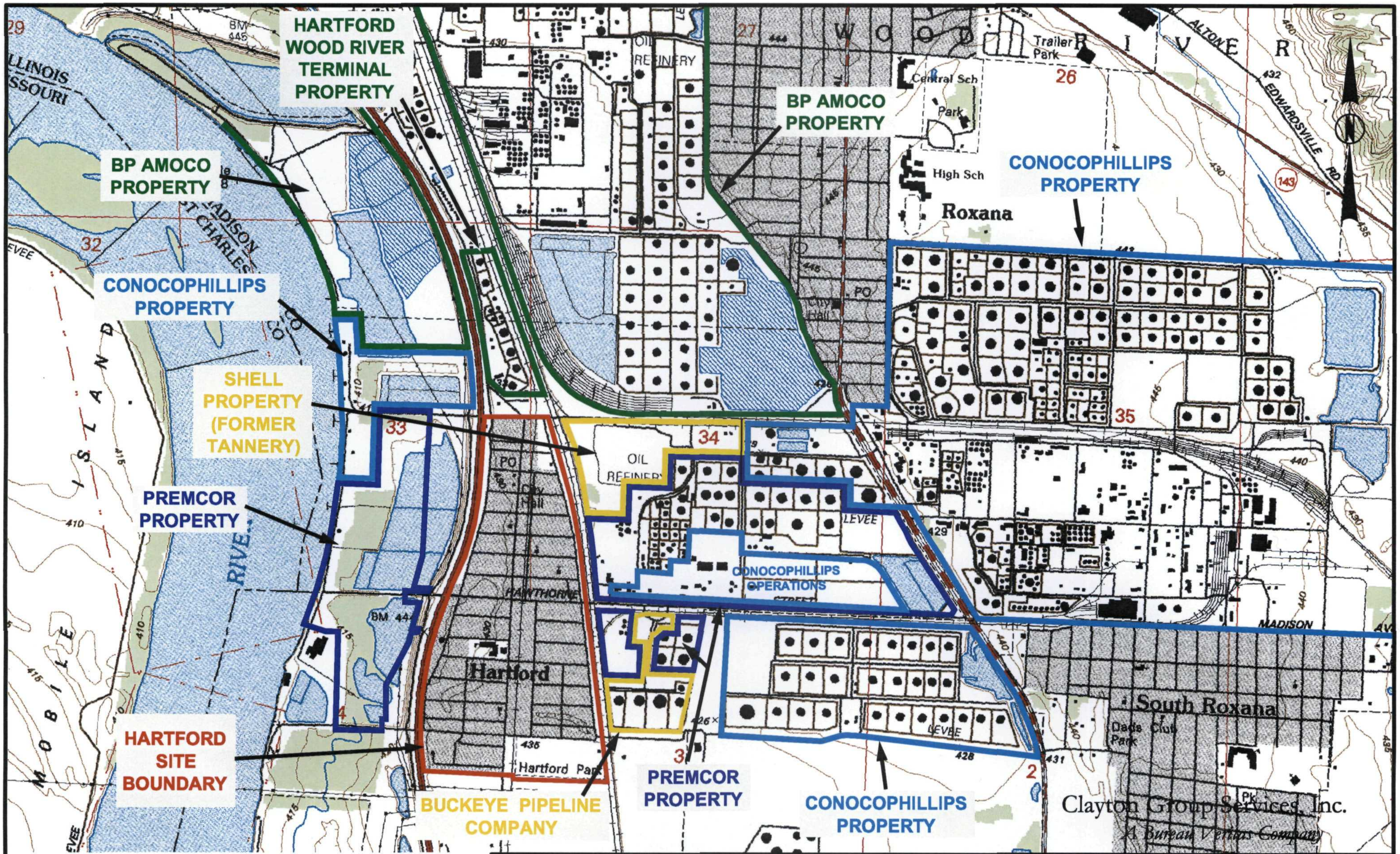
FIGURES



** NOT TO SCALE **

SOURCE:
USGS 7.5 MINUTE SERIES TOPOGRAPHIC MAP
(WOOD RIVER, ILL.-MO. – rev.1994)

CHK BY	
DWN BY	BCP
DATE	11-15-05
SCALE	AS SHOWN
CAD NO.	0309512001B
PRJ NO.	15-03095.14

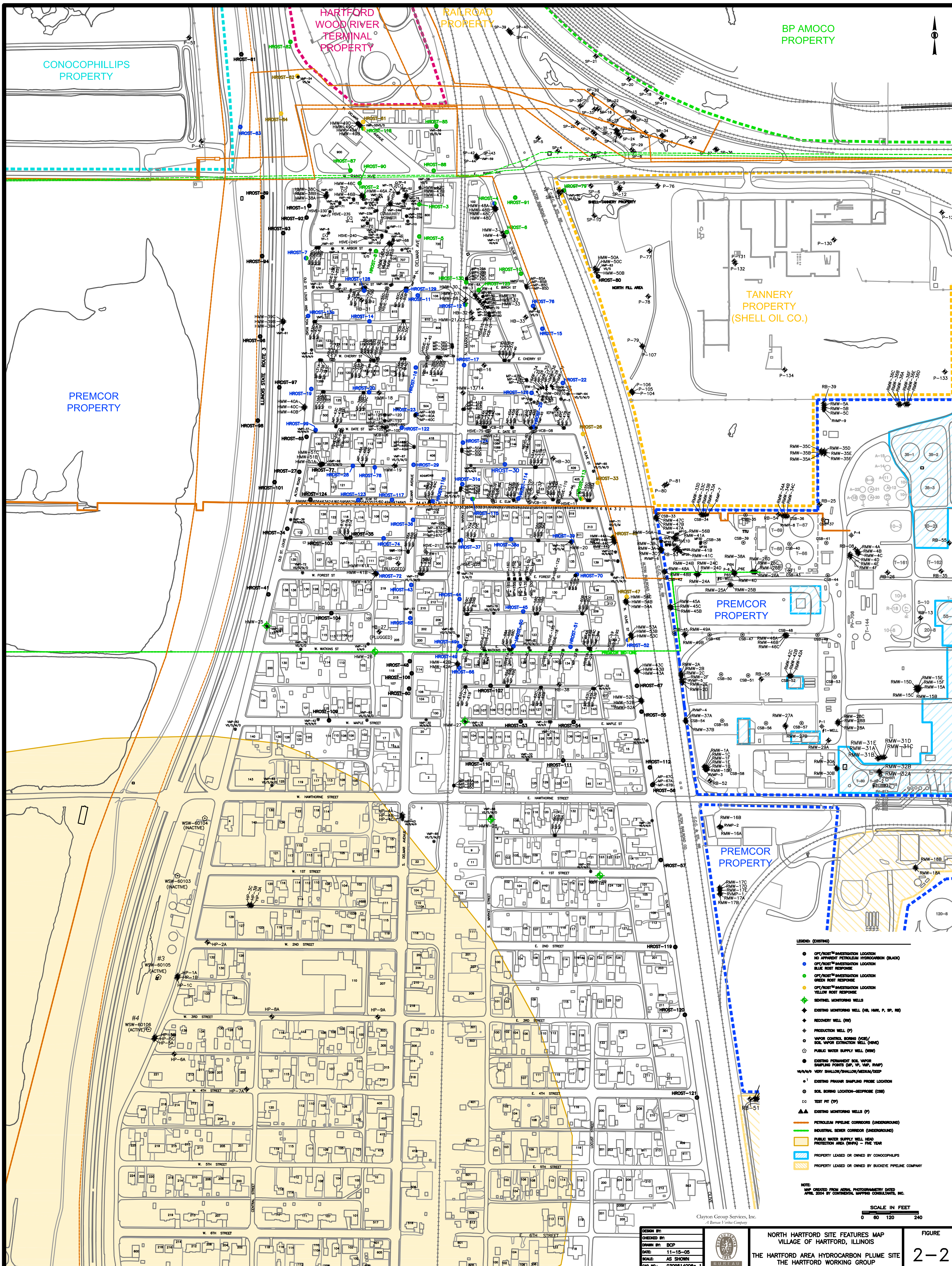
VILLAGE OF HARTFORD, IL
AND SURROUNDING AREA MAP

THE HARTFORD AREA HYDROCARBON PLUME SITE
THE HARTFORD WORKING GROUP
HARTFORD, ILLINOIS

BUREAU VERITAS

FIGURE

2-1



HARTFORD WOOD RIVER TERMINAL PROPERTY
RAILROAD PROPERTY
BP AMOCO PROPERTY
CONOCOPHILLIPS PROPERTY
PREMCOR PROPERTY
TANNERY PROPERTY (SHELL OIL CO.)
PREMCOR PROPERTY
PREMCOR PROPERTY
LEGEND: (EXISTING)
CPT/ROST™ INVESTIGATION LOCATION NO APPARENT PETROLEUM HYDROCARBON (BLACK)
CPT/ROST™ INVESTIGATION LOCATION BLUE ROST RESPONSE
CPT/ROST™ INVESTIGATION LOCATION GREEN ROST RESPONSE
CPT/ROST™ INVESTIGATION LOCATION YELLOW ROST RESPONSE
SENTINEL MONITORING WELLS
EXISTING MONITORING WELL (HB, HMW, P, SP, RB)
RECOVERY WELL (RW)
PRODUCTION WELL (P)
VAPOR CONTROL BORING (VCB)/ SOIL VAPOR EXTRACTION WELL (HSVE)
PUBLIC WATER SUPPLY WELL (WSW)
EXISTING PERMANENT SOIL VAPOR SAMPLING POINTS (MP, VP, VMP, RVMP)
VS/S/M/D VERY SHALLOW/SHALLOW/MEDIUM/DEEP
EXISTING PRAXAIR SAMPLING PROBE LOCATION
SOIL BORING LOCATION-GEOPROBE (CSB)
TEST PIT (TP)
EXISTING MONITORING WELLS (P)
PETROLEUM PIPELINE CORRIDORS (UNDERGROUND)
INDUSTRIAL SEWER CORRIDOR (UNDERGROUND)
PUBLIC WATER SUPPLY WELL HEAD PROTECTION AREA (WHPA) – FIVE YEAR
PROPERTY LEASED OR OWNED BY CONOCOPHILIPS
PROPERTY LEASED OR OWNED BY BUCKEYE PIPELINE COMPANY
NOTE:
MAP CREATED FROM AERIAL PHOTOGRAMMETRY DATED APRIL 2004 BY CONTINENTAL MAPPING CONSULTANTS, INC.
SCALE IN FEET
0 60 120 240
Clayton Group Services, Inc.
A Bureau Veritas Company
DESIGN BY:
CHECKED BY:
DRAWN BY: BCP
DATE: 11-15-05
SCALE: AS SHOWN
CAD NO.: 0309514006a_1
PROJECT NO.: 15-03095.14
NORTH HARTFORD SITE FEATURES MAP
VILLAGE OF HARTFORD, ILLINOIS
THE HARTFORD AREA HYDROCARBON PLUME SITE
THE HARTFORD WORKING GROUP
HARTFORD, ILLINOIS
FIGURE
2-2

Legend

Gauged Product
Source: John Mathes & Assoc., Inc.
1978 Product Contours
1978 Gauged Extent

Pipeline Installation Date
Early 1940s
Early 1950s

4-8" Pipelines & 3-8" & 1-3" Pipelines Source:
Wood River Refining Corp. Drwg. # WR00-RB1 1943

2-10" Pipelines & 2-10" & 1-14" Pipelines Source:
Wood River Refining Corp. Drwg. # WR017-FM3 1952

Aerial Photo Number - Illinois Department of Transportation USDA-40-17119 6/9/78

HISTORIC AERIAL - JUNE1978

THE HARTFORD AREA HYDROCARBON PLUME SITE
THE HARTFORD WORKING GROUP
HARTFORD, ILLINOIS

0 60 120 240 360 480 Feet

FIGURE 2-3

BUREAU VERITAS
Clayton Group Services, Inc
A Bureau Veritas Company

Legend

Gauged Product
Source: John Mathes & Assoc., Inc.
1982 Product Contours
1982 Gauged Extent

Pipeline Installation Date

Early 1940s	4-8" Pipelines & 3-8" & 1-3" Pipelines Source: Wood River Refining Corp. Drwg. # WR00-RB1 1943
Early 1950s	2-10" Pipelines & 2-10" & 1-14" Pipelines Source: Wood River Refining Corp. Drwg. # WR017-FM3 1952
Early 1980s	2-10" & 1-14" Pipelines Source: Clark Oil & Refining Corp. Drwg. # WR043-FB-29 1982

Aerial Photo Number - Illinois Department of Transportation 3890-44-IL476 4/7/88

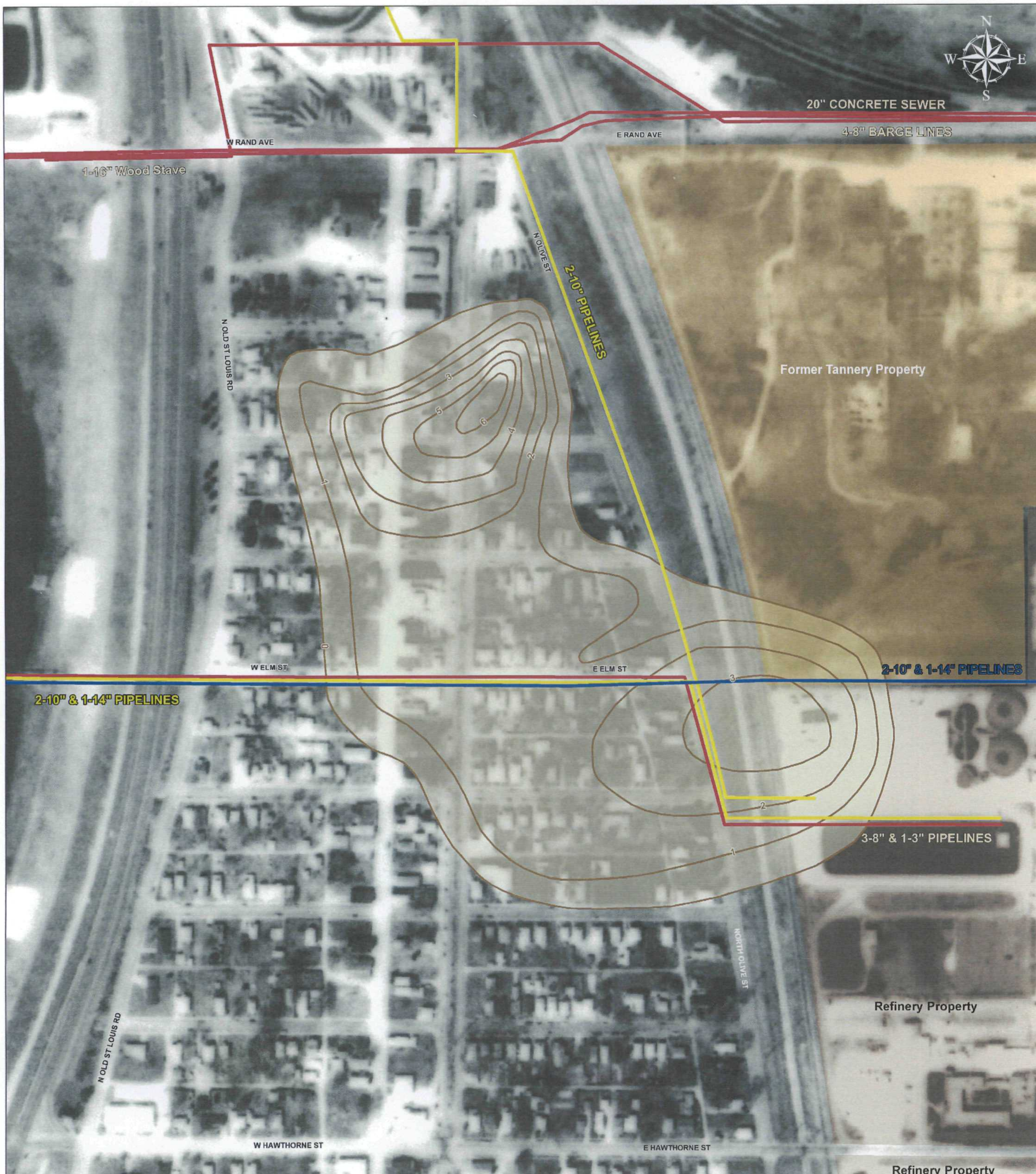
HISTORIC AERIAL - APRIL 1988

THE HARTFORD AREA HYDROCARBON PLUME SITE
THE HARTFORD WORKING GROUP
HARTFORD, ILLINOIS

0 60 120 240 360 480 Feet

FIGURE 2-4

BUREAU VERITAS
Clayton Group Services, Inc
A Bureau Veritas Company



Legend

Gauged Product
Source:
Engineering-Science, Inc.
1990 Product Contours
1990 Gauged Extent

Pipeline Installation Date
Early 1940s
Early 1950s
Early 1980s

4-8" Pipelines & 3-8" & 1-3" Pipelines Source:
Wood River Refining Corp. Drwg. # WR00-RB1 1943

2-10" Pipelines & 2-10" & 1-14" Pipelines Source:
Wood River Refining Corp. Drwg. # WR017-FM3 1952

2-10" & 1-14" Pipelines Source:
Clark Oil & Refining Corp. Drwg. # WR043-FB-29 1982

Aerial Photo Number - Illinois Department of Transportation NAPP93 5798-253 3/7/93

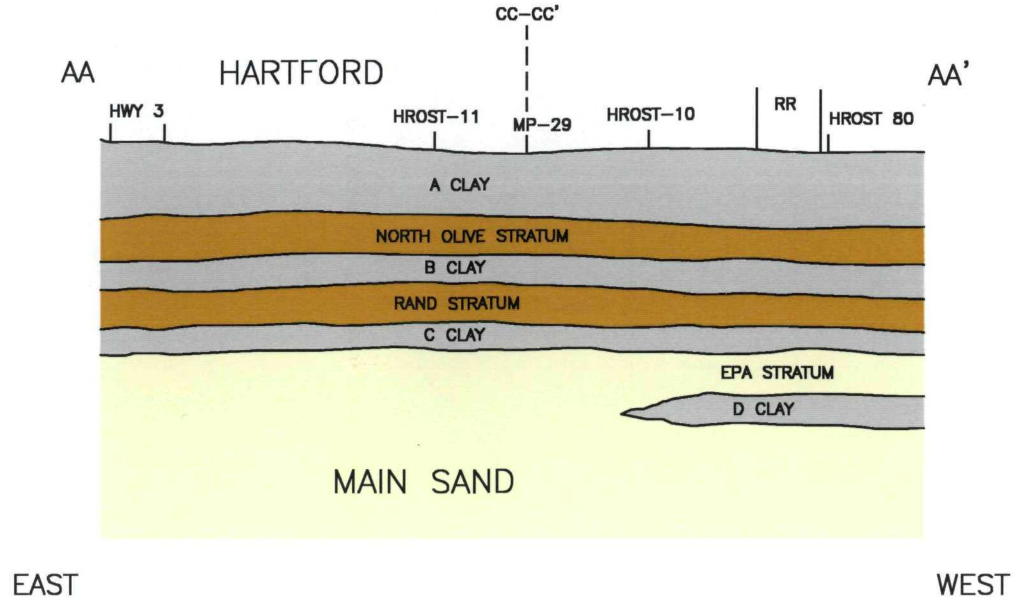
HISTORIC AERIAL - MARCH 1993

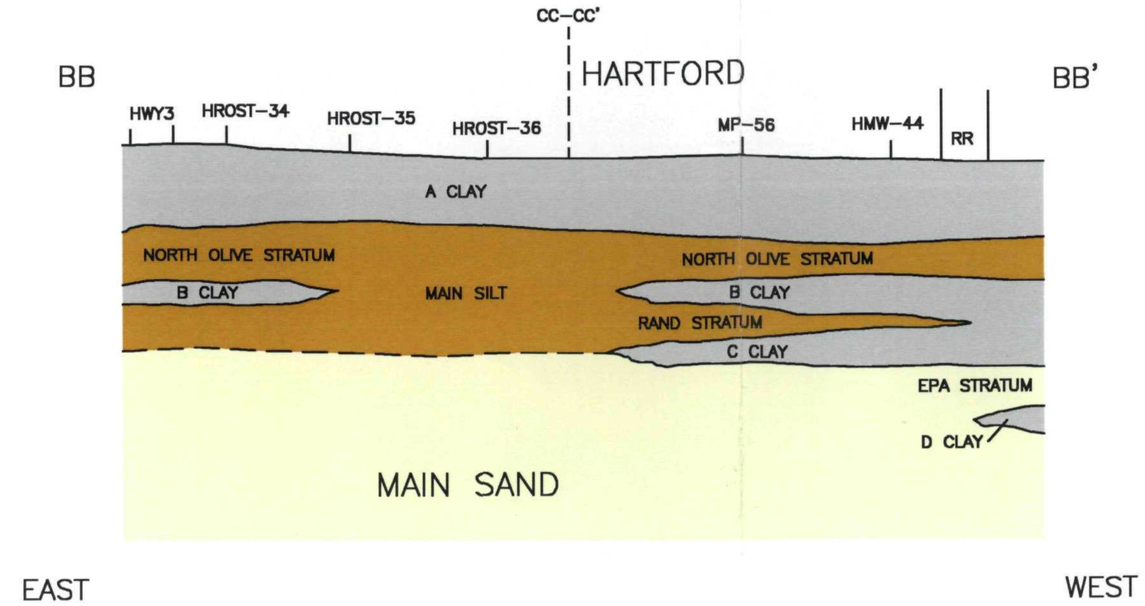
THE HARTFORD AREA HYDROCARBON PLUME SITE
THE HARTFORD WORKING GROUP
HARTFORD, ILLINOIS

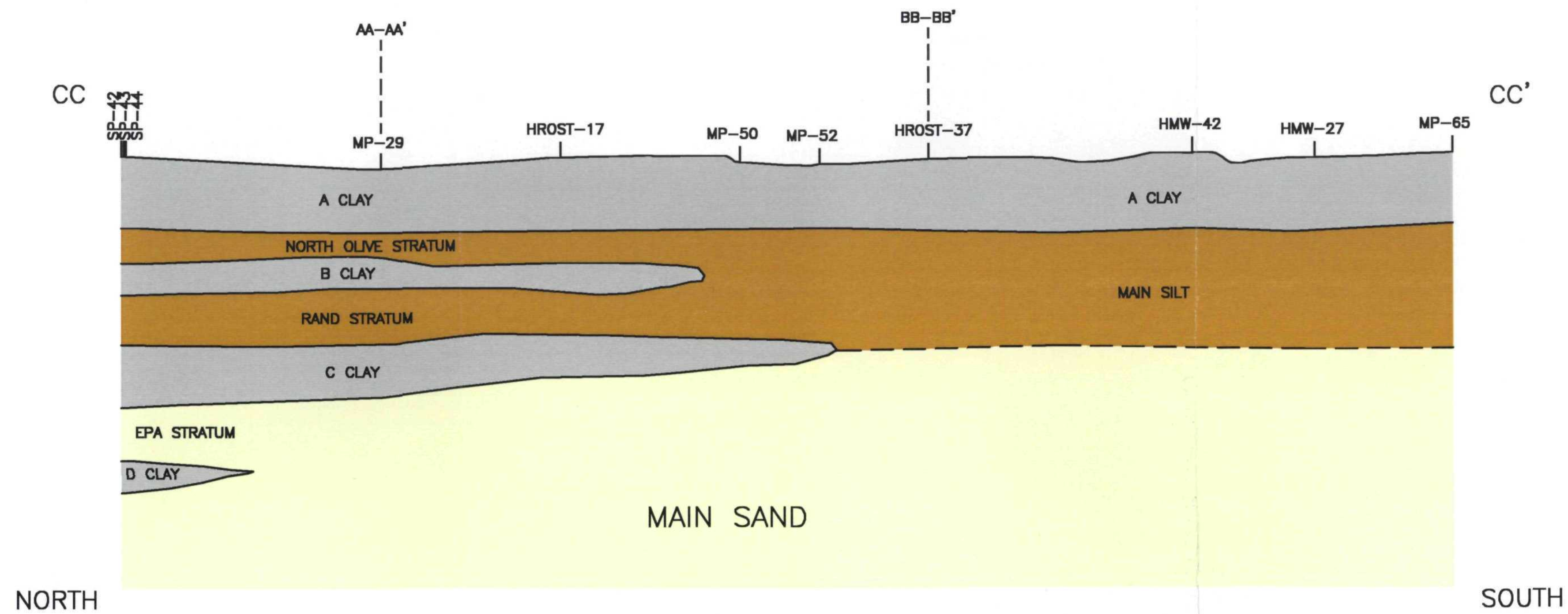
0 60 120 240 360 480 Feet

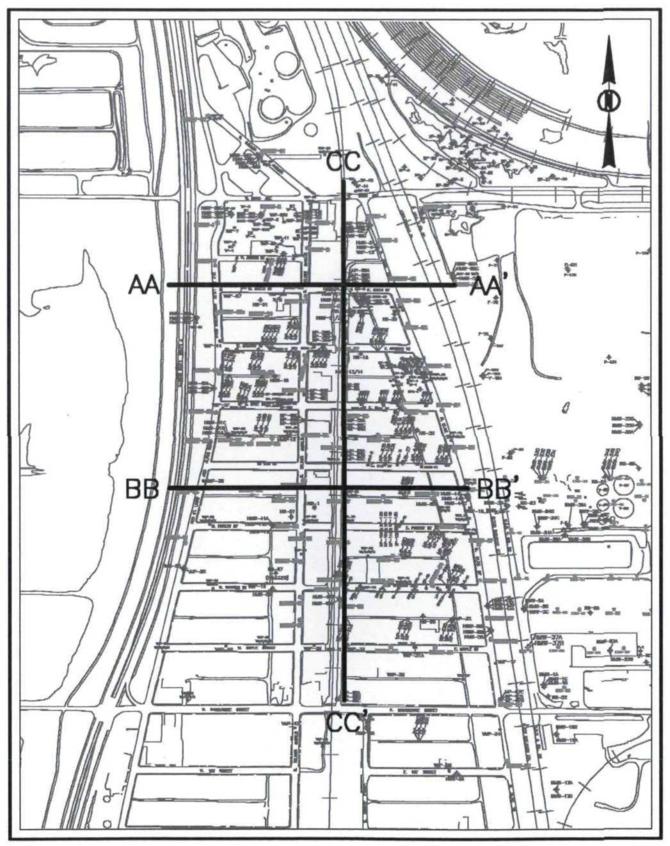
FIGURE 2-5

BUREAU VERITAS









CROSS SECTION REFERENCE

NOTES:

1. VERTICAL AND LATERAL EXTENT OF GEOLOGIC STRATA REFLECT GENERALIZED REPRESENTATIONS FOR THE PURPOSE OF SIMPLIFYING THE UNDERSTANDING AND IDENTIFICATION OF THE MAJOR LITHOLOGIC STRATA WITHIN THE STUDY AREA.
2. VERTICAL EXTENT OF STRATA NOT TO SCALE.
3. BASE OF MAIN SAND NOT SHOWN.

Clayton Group Services, Inc.
A Bureau Veritas Company

CHECK BY DJL	
DRAWN BY OS	
DATE	12-7-05
SCALE	AS SHOWN
CAD NO.	0309514020a
PRJ NO.	15-03095.14

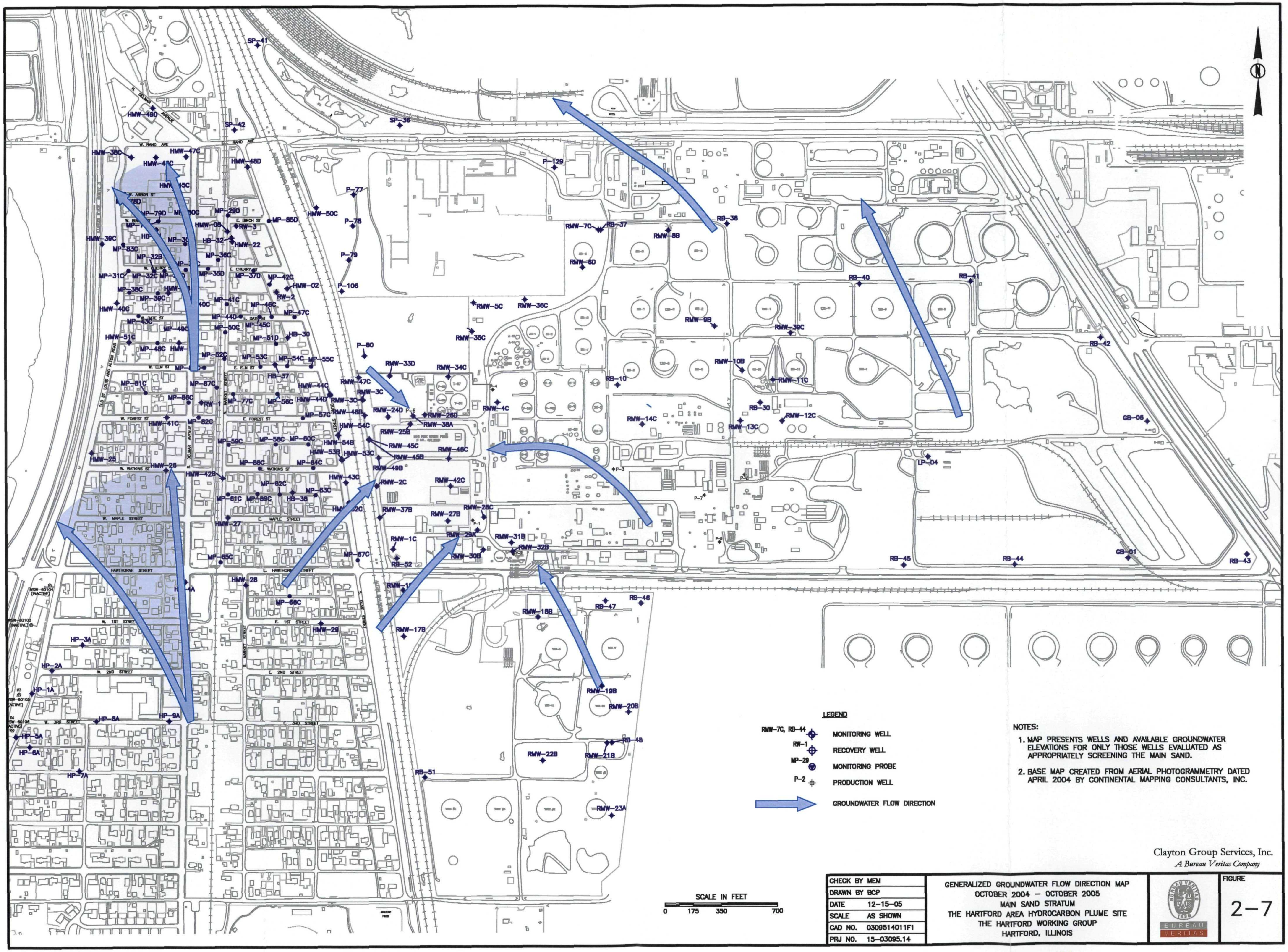
GENERALIZED GEOLOGIC CROSS SECTIONS
AA–AA', BB–BB', AND CC–CC'

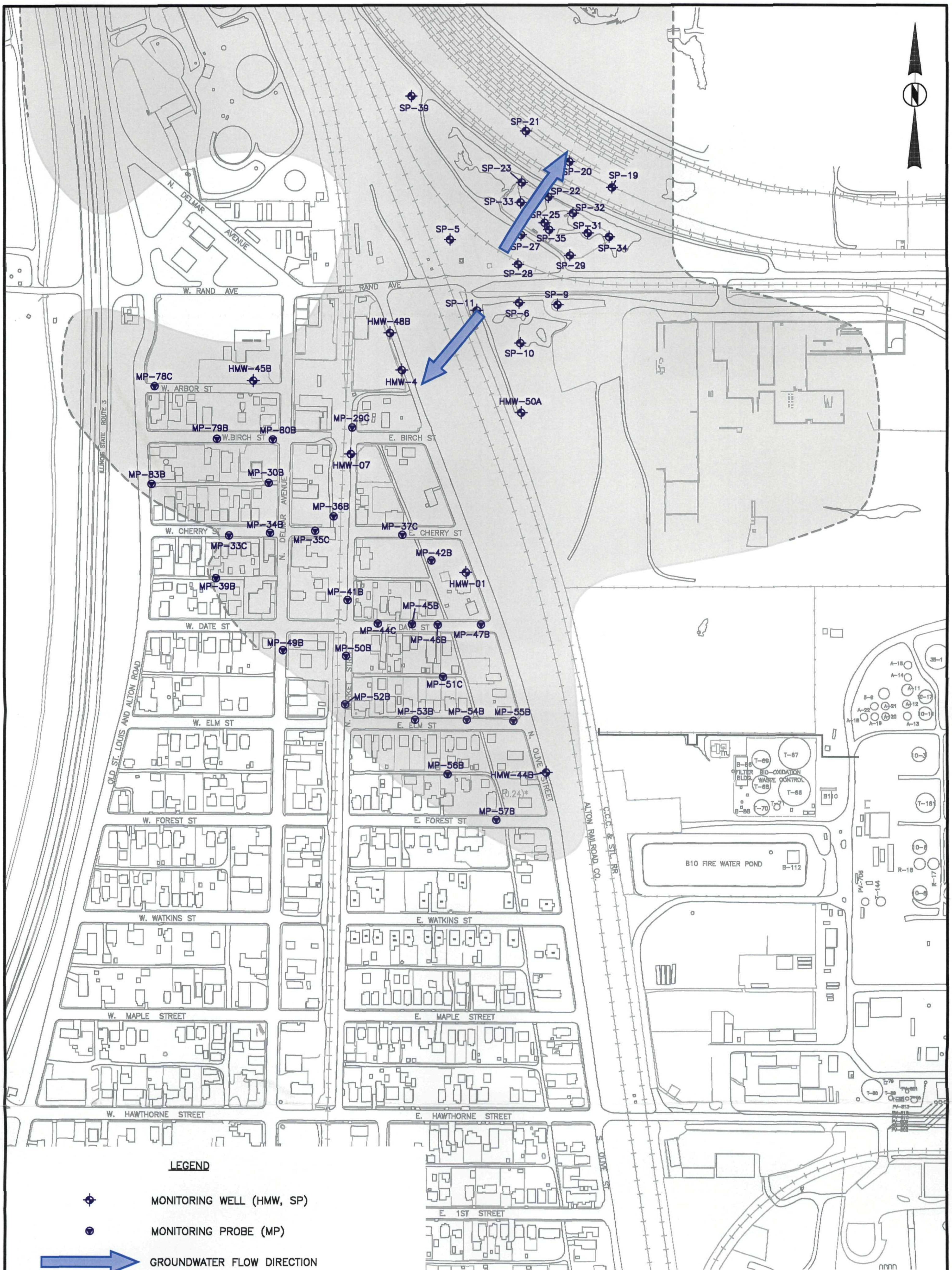
THE HARTFORD AREA HYDROCARBON PLUME SITE
THE HARTFORD WORKING GROUP
HARTFORD, ILLINOIS

BUREAU VERITAS

FIGURE

2–6


W. RAND AVE
E. BIRCH ST
E. CHERRY ST
W. ELM ST
W. FOREST ST
W. WATKINS ST
W. MAPLE STREET
HAWTHORNE STREET
W. 1ST STREET
W. 2ND STREET
W. 3RD STREET
LEGEND
RMW-7C, RB-44 MONITORING WELL
RW-1 RECOVERY WELL
MP-29 MONITORING PROBE
P-2 PRODUCTION WELL
GROUNDWATER FLOW DIRECTION
NOTES:
1. MAP PRESENTS WELLS AND AVAILABLE GROUNDWATER ELEVATIONS FOR ONLY THOSE WELLS EVALUATED AS APPROPRIATELY SCREENING THE MAIN SAND.
2. BASE MAP CREATED FROM AERIAL PHOTOGRAMMETRY DATED APRIL 2004 BY CONTINENTAL MAPPING CONSULTANTS, INC.
SCALE IN FEET
0 175 350 700
Clayton Group Services, Inc.
A Bureau Veritas Company
CHECK BY MEM
DRAWN BY BCP
DATE 12-15-05
SCALE AS SHOWN
CAD NO. 0309514011F1
PRJ NO. 15-03095.14
GENERALIZED GROUNDWATER FLOW DIRECTION MAP
OCTOBER 2004 – OCTOBER 2005
MAIN SAND STRATUM
THE HARTFORD AREA HYDROCARBON PLUME SITE
THE HARTFORD WORKING GROUP
HARTFORD, ILLINOIS
FIGURE
2-7



LEGEND

MONITORING WELL (HMW, SP)

MONITORING PROBE (MP)

GROUNDWATER FLOW DIRECTION

INTERPRETED EXTENT OF STRATUM
(DASHED WHERE EXTRAPOLATED)

SCALE IN FEET

0 150 300 600

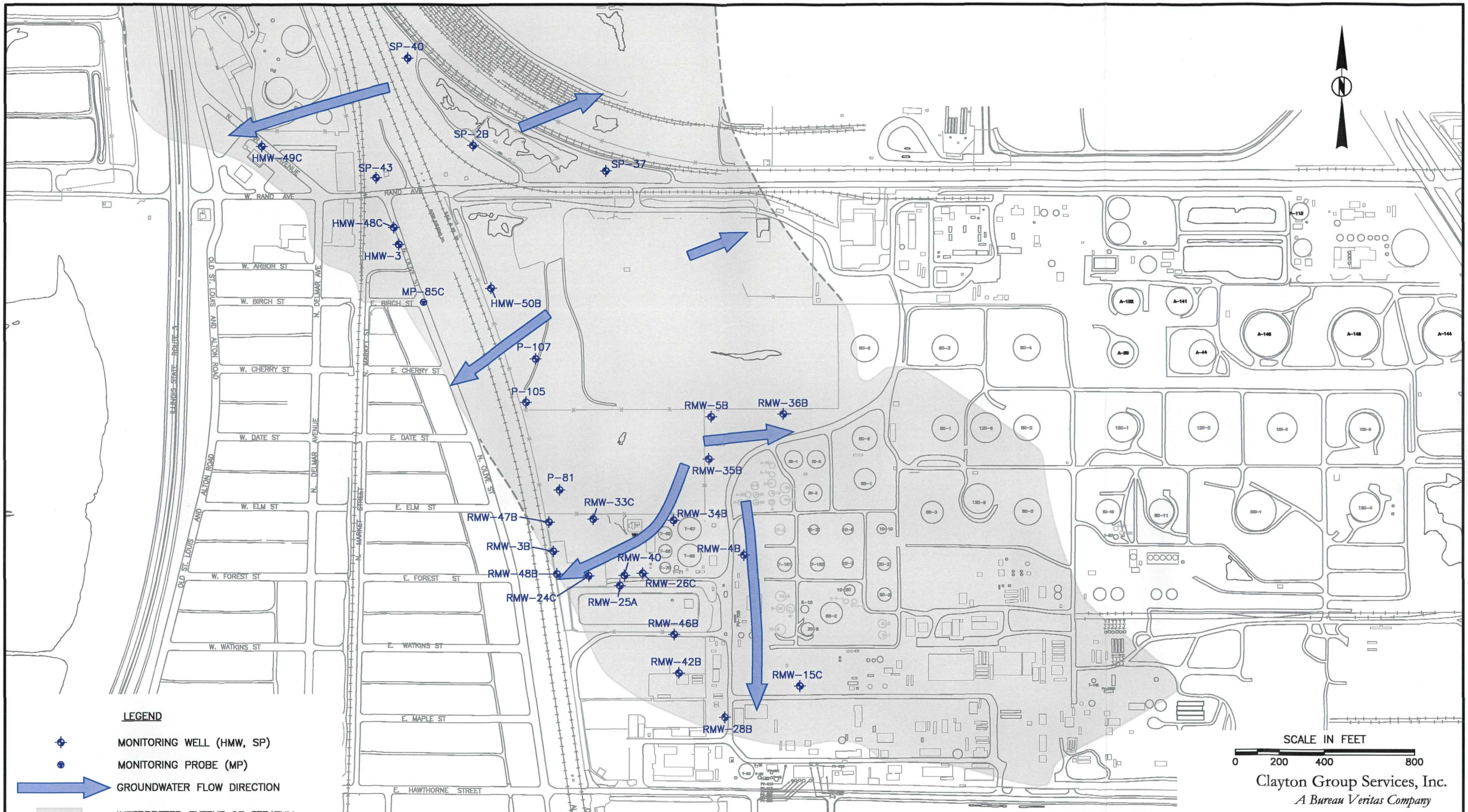
Clayton Group Services, Inc.
A Bureau Veritas Company

CHECK BY	MEM
DRAWN BY	OS
DATE	12-7-05
SCALE	AS SHOWN
CAD NO.	0309514011F2
PRJ NO.	15-03095

GENERALIZED GROUNDWATER FLOW DIRECTION MAP
OCTOBER 2004 – OCTOBER 2005
RAND STRATUM
THE HARTFORD AREA HYDROCARBON PLUME SITE
THE HARTFORD WORKING GROUP
HARTFORD, ILLINOIS

BUREAU VERITAS 1828

FIGURE
2-8



LEGEND

- MONITORING WELL (HMW, SP)
- MONITORING PROBE (MP)
- GROUNDWATER FLOW DIRECTION
- INTERPRETED EXTENT OF STRATUM (DASHED WHERE EXTRAPOLATED)

NOTE:
MAP CREATED FROM AERIAL PHOTOGRAMMETRY DATED APRIL, 2004 BY CONTINENTIAL MAPPING CONSULTANTS, INC.

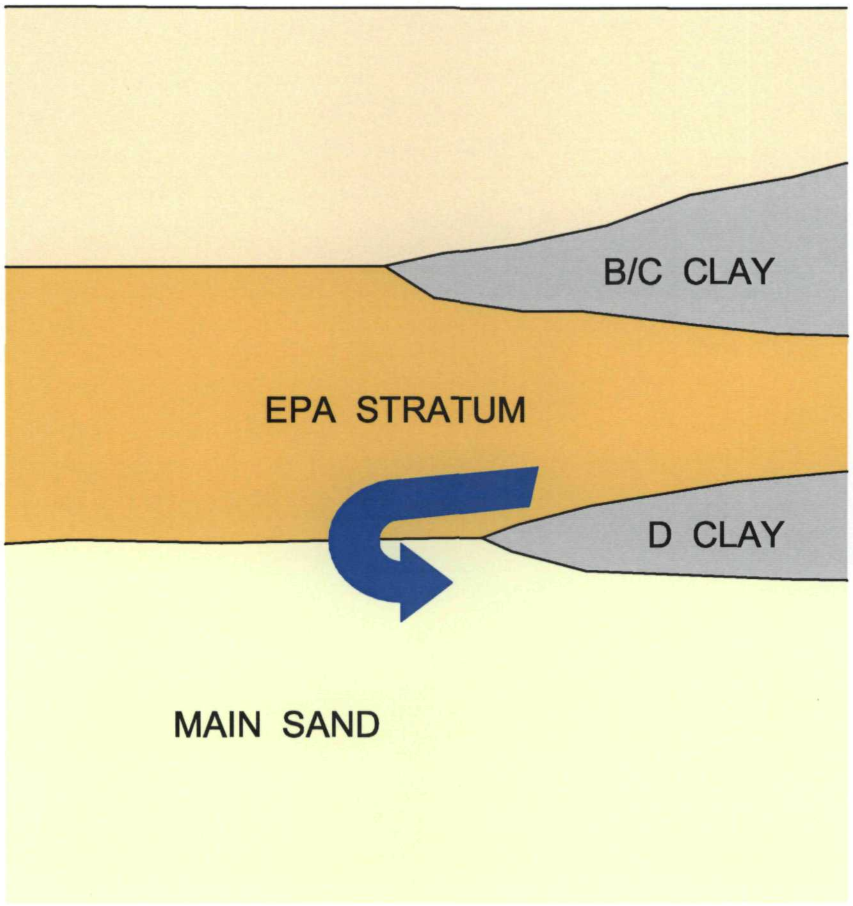
Clayton Group Services, Inc.
A Bureau Veritas Company

CHECK BY	MEM
DRAWN BY	BCP
DATE	12-7-05
SCALE	AS SHOWN
CAD NO.	030951401 1f3
PRJ NO.	15-03095.14

GENERALIZED GROUNDWATER FLOW DIRECTION MAP
OCTOBER 2004 – OCTOBER 2005
EPA STRATUM
THE HARTFORD AREA HYDROCARON PLUME SITE
THE HARTFORD WORKING GROUP
HARTFORD, ILLINOIS

BUREAU VERITAS 1828

FIGURE
2-9

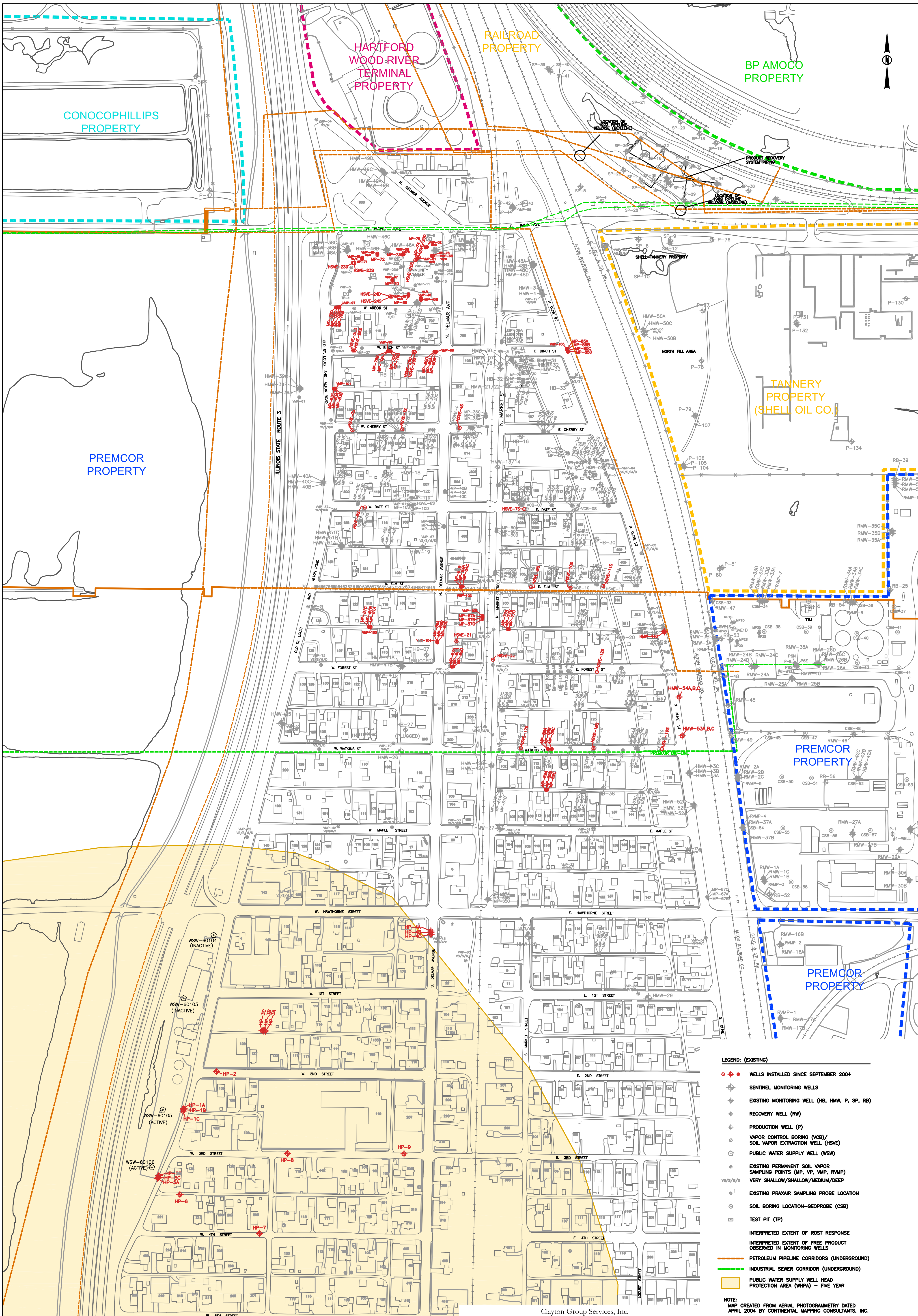


LEGEND

GROUNDWATER FLOW DIRECTION

Clayton Group Services, Inc.
A Bureau Veritas Company

CHECK BY KDC DRAWN BY BCP DATE 12-7-05 SCALE NO SCALE CAD NO. 0309514020G PRJ NO. 15-03095.14	GROUNDWATER FLOW SCHEMATIC EPA AND MAIN SAND STRATA THE HARTFORD AREA HYDROCARBON PLUME SITE THE HARTFORD WORKING GROUP HARTFORD, ILLINOIS	BUREAU VERITAS	FIGURE 2-10



SCALE IN FEET
0 80 160 320

DRAFT WORK IN PROGRESS

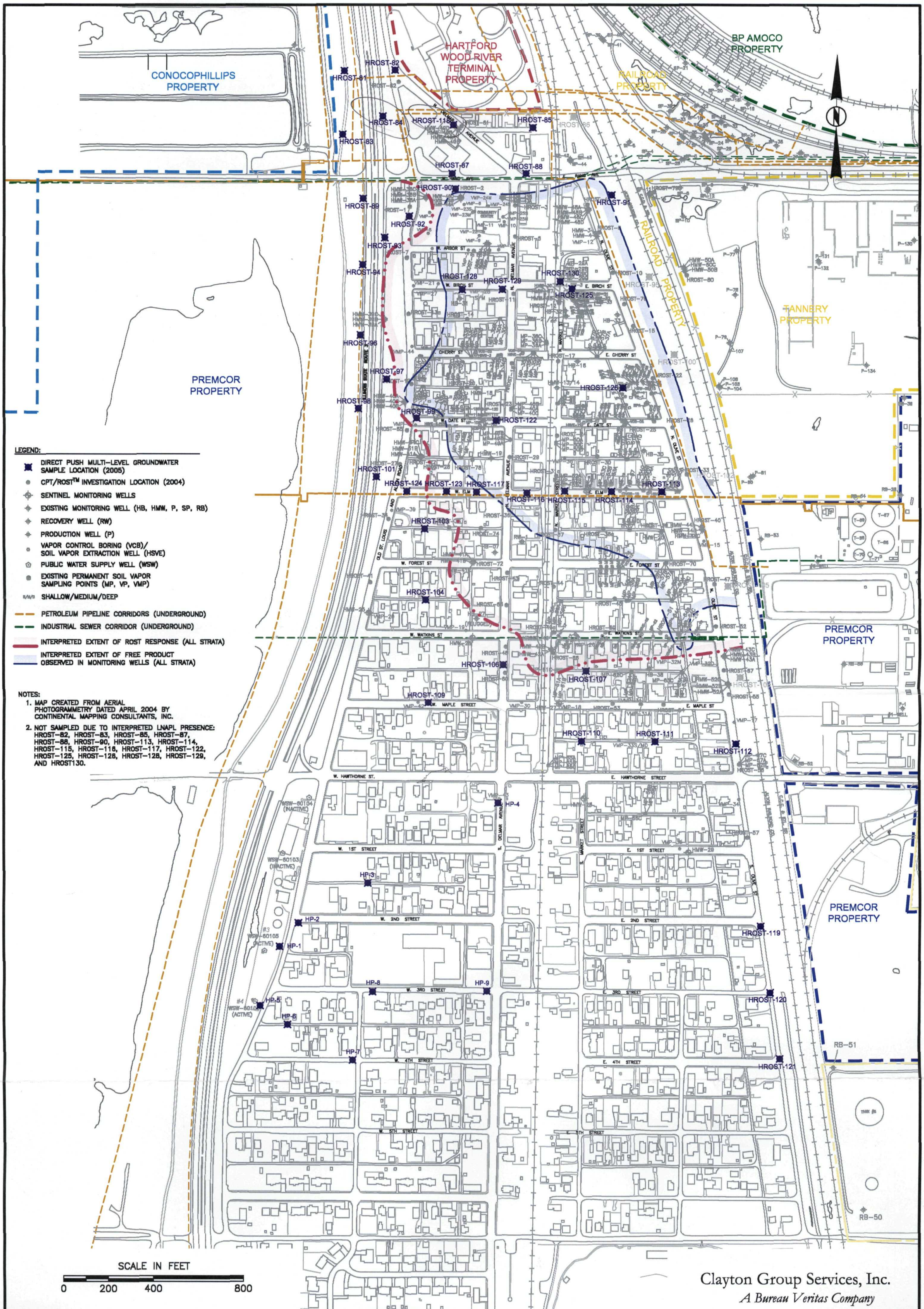
Clayton Group Services, Inc.
A Bureau Veritas Company

DESIGN BY:	
CHECKED BY:	KDC
DRAWN BY:	OS
DATE:	12–7–05
SCALE:	AS SHOWN
CAD NO.:	0309514011M
PROJECT NO.:	15–03095.14

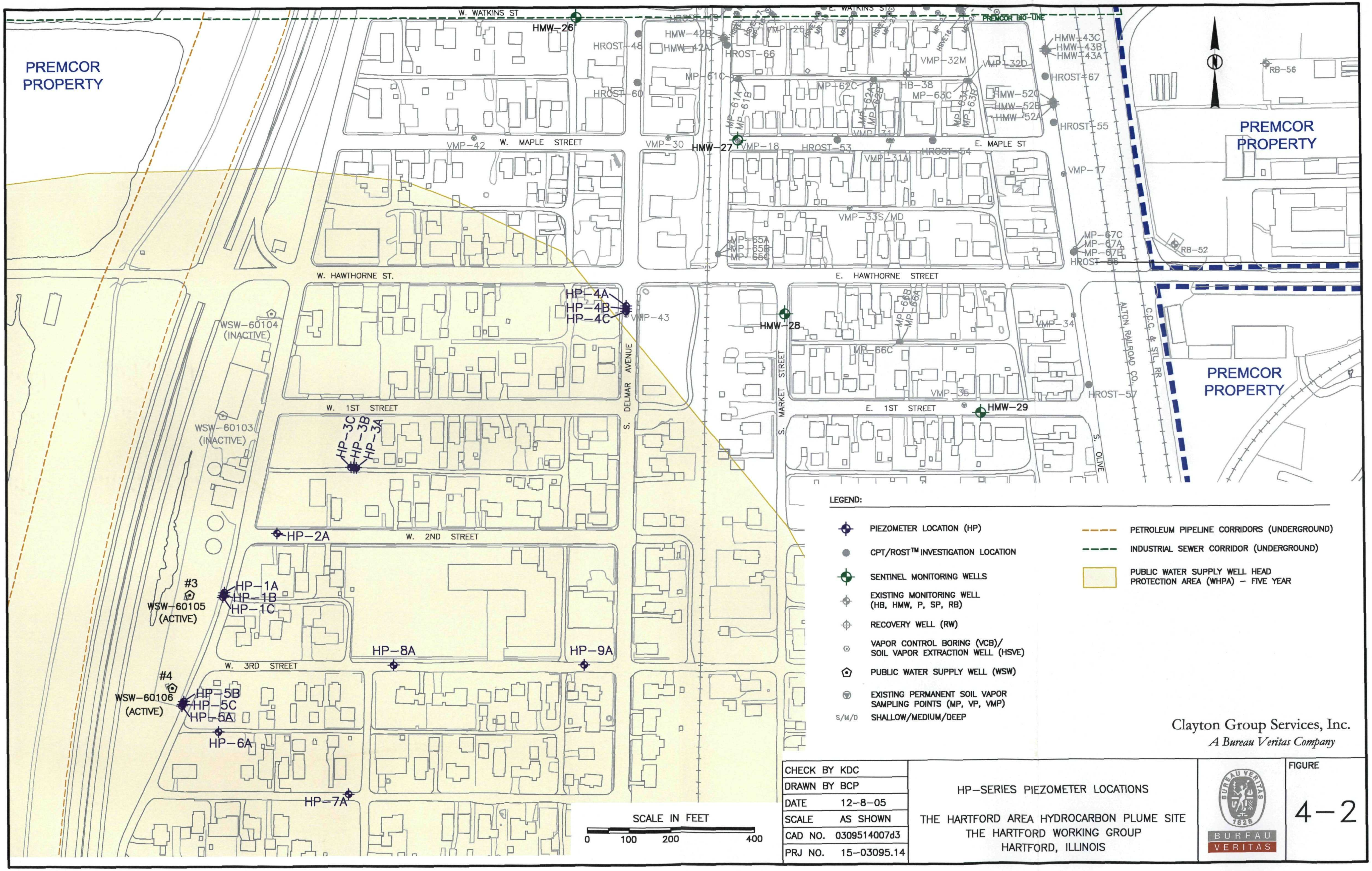
BUREAU VERITAS 1828

LOCATIONS OF MONITORING FEATURES AND SOIL VAPOR EXTRACTION WELLS INSTALLED FROM OCTOBER 2004 THROUGH NOVEMBER 2005
THE HARTFORD AREA HYDROCARBON PLUME SITE
THE HARTFORD WORKING GROUP
HARTFORD, ILLINOIS

FIGURE 3-1

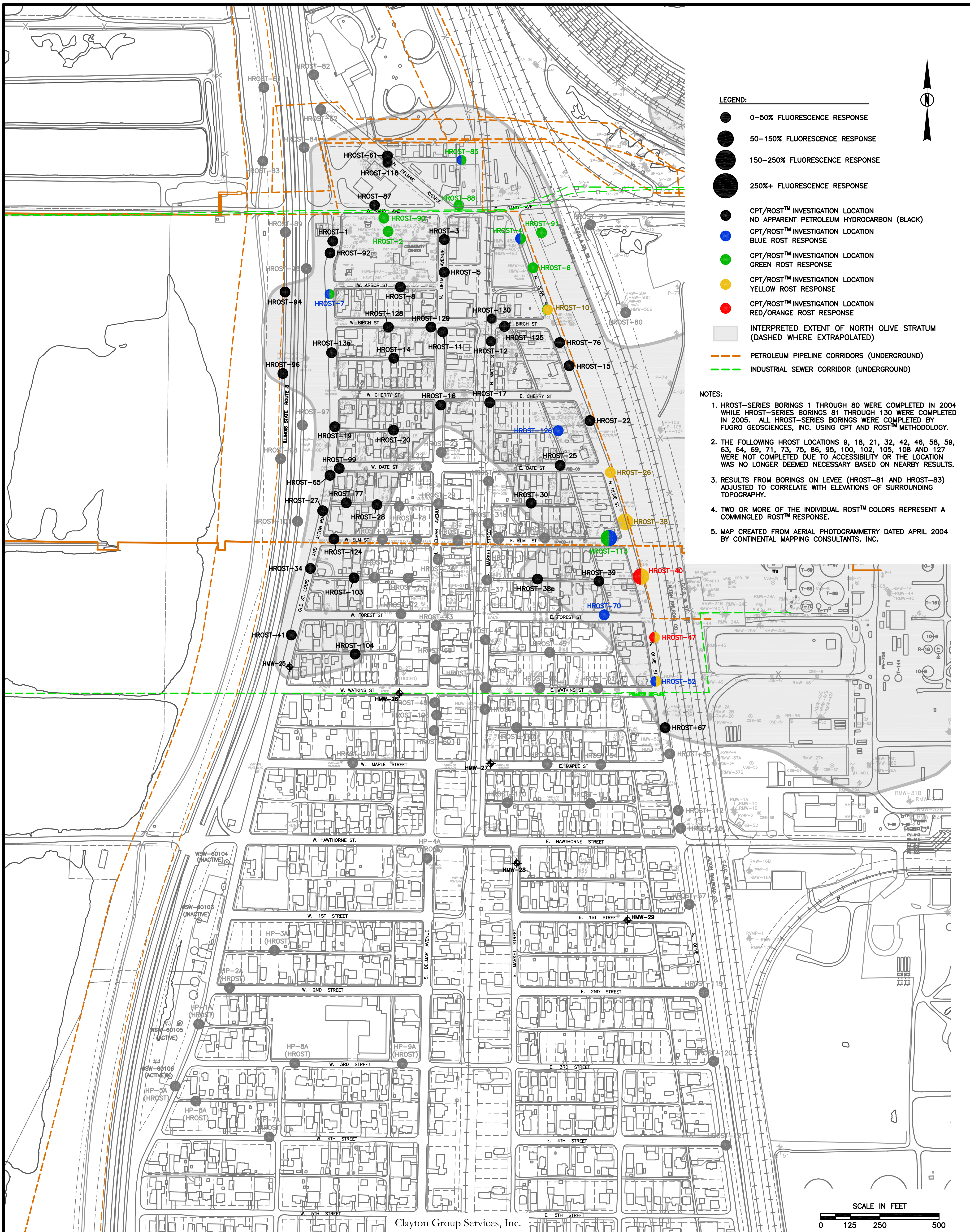


CHECK BY KDC	DIRECT PUSH MULTI-LEVEL GROUNDWATER INVESTIGATION LOCATIONS THE HARTFORD AREA HYDROCARBON PLUME SITE THE HARTFORD WORKING GROUP HARTFORD, ILLINOIS	BUREAU VERITAS 1828	FIGURE 4-1
DRAWN BY OS			
DATE 12-7-05			
SCALE AS SHOWN			
CAD NO. 030951401 1I			
PRJ NO. 15-03095.14			



Clayton Group Services, Inc.
A Bureau Veritas Company

CHECK BY KDC	HP-SERIES PIEZOMETER LOCATIONS THE HARTFORD AREA HYDROCARBON PLUME SITE THE HARTFORD WORKING GROUP HARTFORD, ILLINOIS	BUREAU VERITAS 1828	FIGURE 4–2
DRAWN BY BCP			
DATE 12-8-05			
SCALE AS SHOWN			
CAD NO. 0309514007d3			
PRJ NO. 15-03095.14			



NOTES:

1. HROST–SERIES BORINGS 1 THROUGH 80 WERE COMPLETED IN 2004 WHILE HROST–SERIES BORINGS 81 THROUGH 130 WERE COMPLETED IN 2005. ALL HROST–SERIES BORINGS WERE COMPLETED BY FUGRO GEOSCIENCES, INC. USING CPT AND ROST™ METHODOLOGY.
2. THE FOLLOWING HROST LOCATIONS 9, 18, 21, 32, 42, 46, 58, 59, 63, 64, 69, 71, 73, 75, 86, 95, 100, 102, 105, 108 AND 127 WERE NOT COMPLETED DUE TO ACCESSIBILITY OR THE LOCATION WAS NO LONGER DEEMED NECESSARY BASED ON NEARBY RESULTS.
3. RESULTS FROM BORINGS ON LEVEE (HROST–81 AND HROST–83) ADJUSTED TO CORRELATE WITH ELEVATIONS OF SURROUNDING TOPOGRAPHY.
4. TWO OR MORE OF THE INDIVIDUAL ROST™ COLORS REPRESENT A COMMINGLED ROST™ RESPONSE.
5. MAP CREATED FROM AERIAL PHOTOGRAMMETRY DATED APRIL 2004 BY CONTINENTAL MAPPING CONSULTANTS, INC.

Clayton Group Services, Inc.
A Bureau Veritas Company

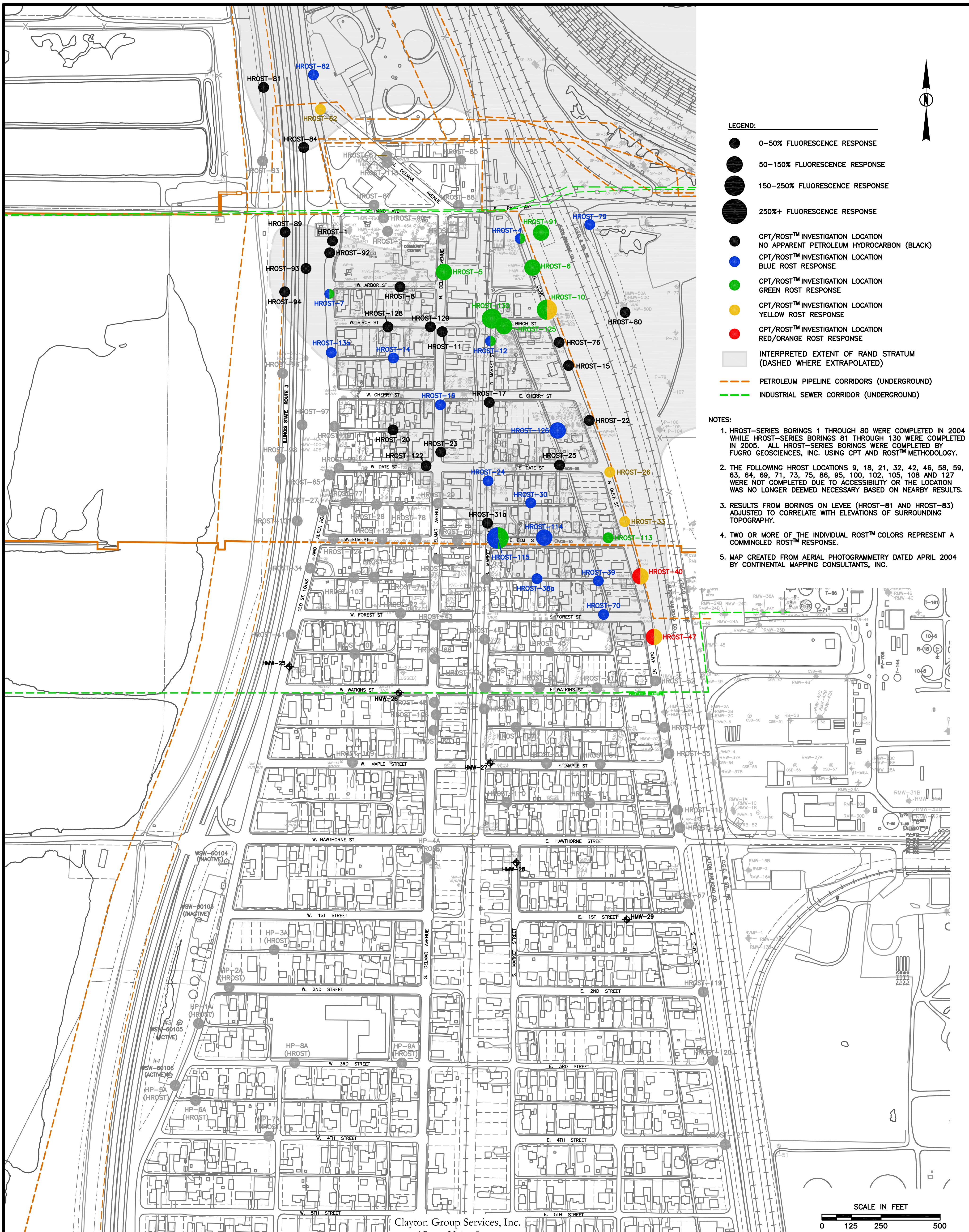
DESIGN BY:	
CHECKED BY:	KDC
DRAWN BY:	BCP/OS
DATE:	12–7–05
SCALE:	AS SHOWN
CAD NO.:	0309514011J1
PROJECT NO.:	15–03095.14

BUREAU VERITAS

ROST RESPONSE IN THE NORTH OLIVE STRATUM
SEPTEMBER 2005

THE HARTFORD AREA HYDROCARBON PLUME SITE
THE HARTFORD WORKING GROUP
HARTFORD, ILLINOIS

FIGURE
5–1



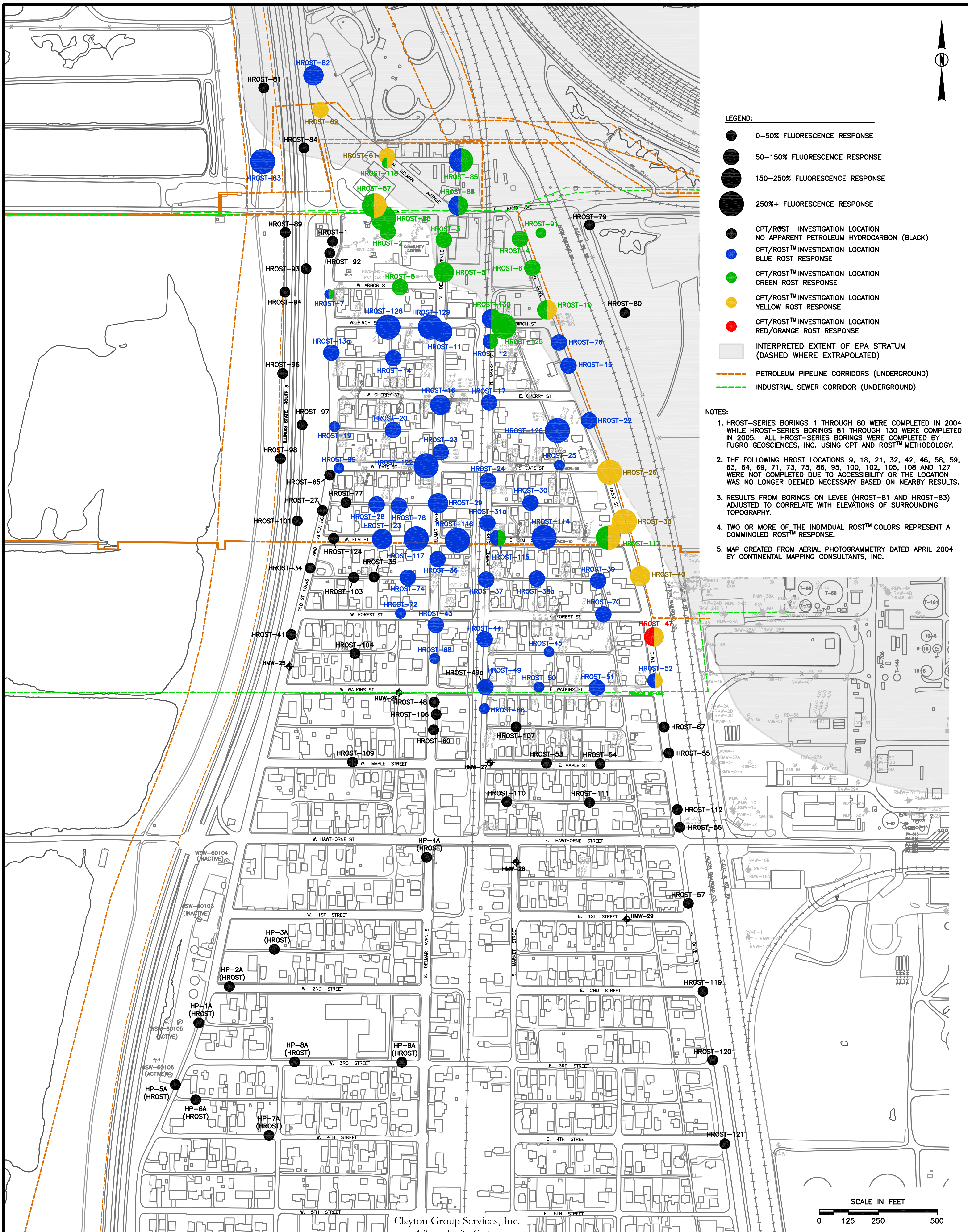
DESIGN BY:	
CHECKED BY:	KDC
DRAWN BY:	BCP/OS
DATE:	12–7–05
SCALE:	AS SHOWN
CAD NO.:	0309514011J2
PROJECT NO.:	15–03095.14

BUREAU VERITAS 1828

ROST RESPONSE IN THE RAND STRATUM
SEPTEMBER 2005

THE HARTFORD AREA HYDROCARBON PLUME SITE
THE HARTFORD WORKING GROUP
HARTFORD, ILLINOIS

FIGURE
5–2



LEGEND:

- 0–50% FLUORESCENCE RESPONSE
- 50–150% FLUORESCENCE RESPONSE
- 150–250% FLUORESCENCE RESPONSE
- 250%+ FLUORESCENCE RESPONSE
- CPT/ROST INVESTIGATION LOCATION NO APPARENT PETROLEUM HYDROCARBON (BLACK)
- CPT/ROST™ INVESTIGATION LOCATION BLUE ROST RESPONSE
- CPT/ROST™ INVESTIGATION LOCATION GREEN ROST RESPONSE
- CPT/ROST™ INVESTIGATION LOCATION YELLOW ROST RESPONSE
- CPT/ROST™ INVESTIGATION LOCATION RED/ORANGE ROST RESPONSE
- INTERPRETED EXTENT OF EPA STRATUM (DASHED WHERE EXTRAPOLATED)
- PETROLEUM PIPELINE CORRIDORS (UNDERGROUND)
- INDUSTRIAL SEWER CORRIDOR (UNDERGROUND)

NOTES:

1. HROST-SERIES BORINGS 1 THROUGH 80 WERE COMPLETED IN 2004 WHILE HROST-SERIES BORINGS 81 THROUGH 130 WERE COMPLETED IN 2005. ALL HROST-SERIES BORINGS WERE COMPLETED BY FUGRO GEOSCIENCES, INC. USING CPT AND ROST™ METHODOLOGY.
2. THE FOLLOWING HROST LOCATIONS 9, 18, 21, 32, 42, 46, 58, 59, 63, 64, 69, 71, 73, 75, 86, 95, 100, 102, 105, 108 AND 127 WERE NOT COMPLETED DUE TO ACCESSIBILITY OR THE LOCATION WAS NO LONGER DEEMED NECESSARY BASED ON NEARBY RESULTS.
3. RESULTS FROM BORINGS ON LEVEE (HROST-81 AND HROST-83) ADJUSTED TO CORRELATE WITH ELEVATIONS OF SURROUNDING TOPOGRAPHY.
4. TWO OR MORE OF THE INDIVIDUAL ROST™ COLORS REPRESENT A COMMINGLED ROST™ RESPONSE.
5. MAP CREATED FROM AERIAL PHOTOGRAMMETRY DATED APRIL 2004 BY CONTINENTAL MAPPING CONSULTANTS, INC.

Clayton Group Services, Inc.
A Bureau Veritas Company

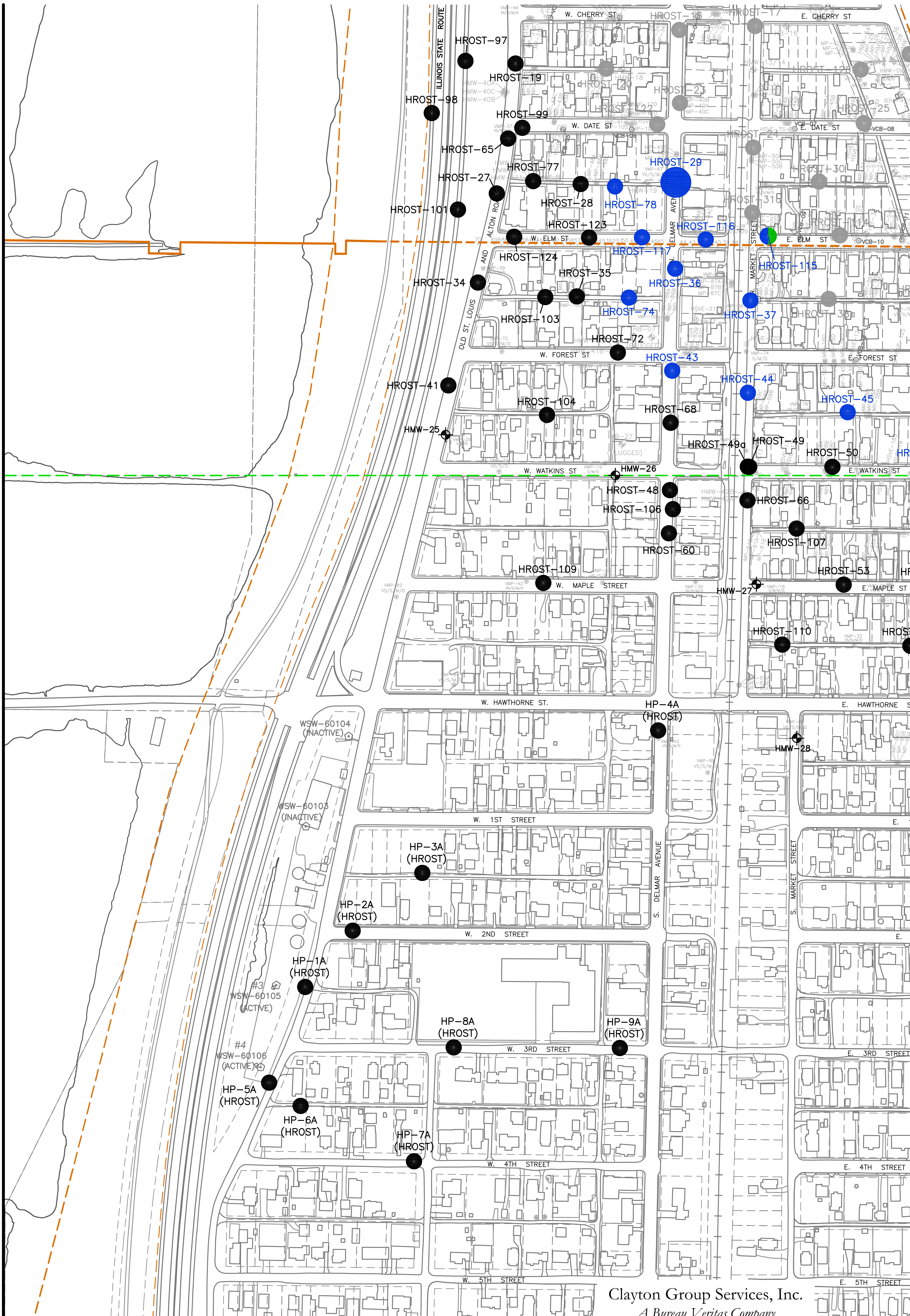
DESIGN BY:	
CHECKED BY:	KDC
DRAWN BY:	BCP
DATE:	12-7-05
SCALE:	AS SHOWN
CAD NO.:	0309514011J3
PROJECT NO.:	15-03095.14

BUREAU VERITAS 1828

ROST RESPONSE IN THE EPA STRATUM AND THE MAIN SAND
SEPTEMBER 2005
THE HARTFORD AREA HYDROCARBON PLUME SITE
THE HARTFORD WORKING GROUP
HARTFORD, ILLINOIS

FIGURE

5-3



Clayton Group Services, Inc.
A Bureau Veritas Company

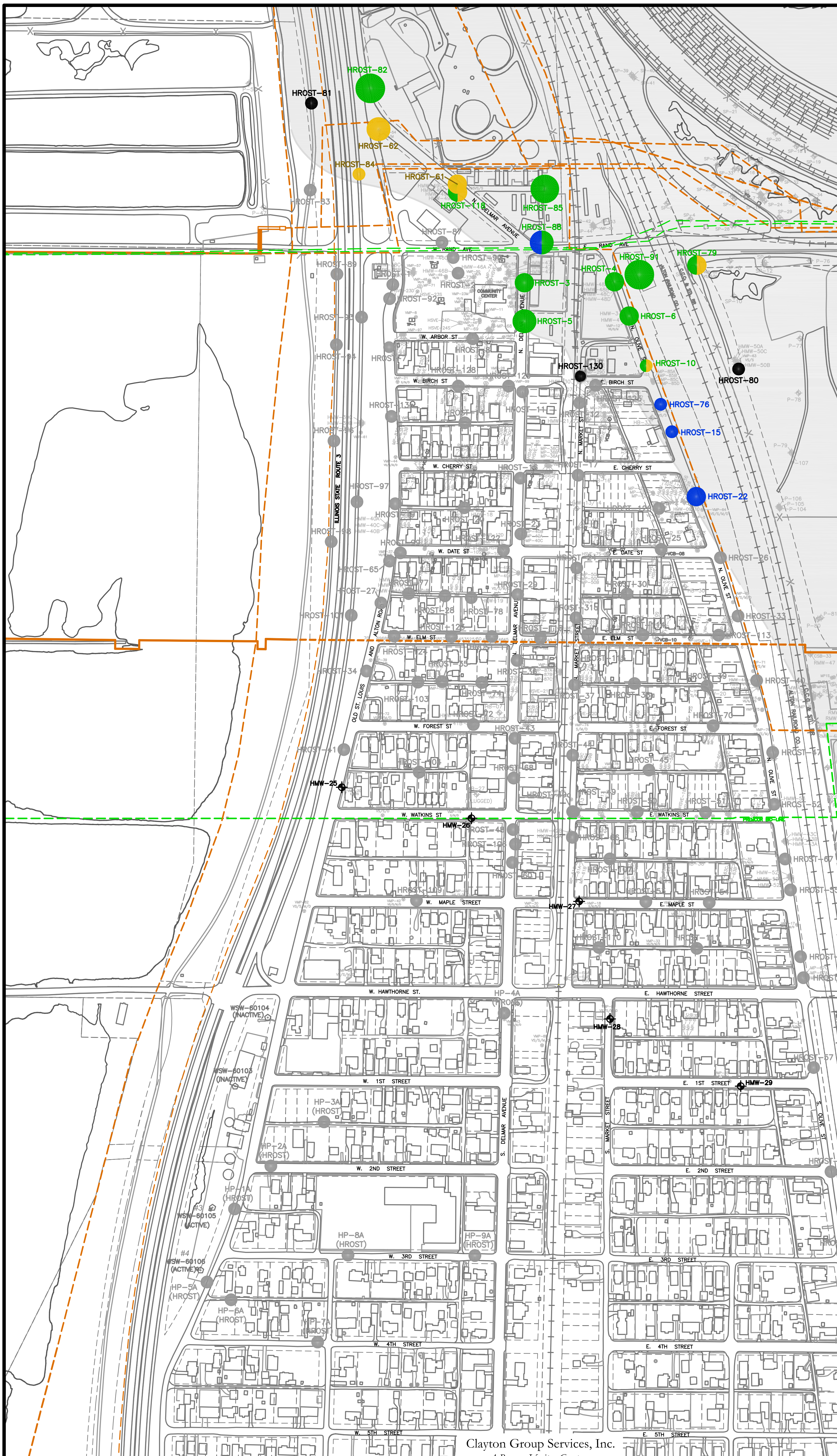
DESIGN BY:	
CHECKED BY:	KDC
DRAWN BY:	BCP
DATE:	12-7-05
SCALE:	AS SHOWN
CAD NO.:	0309514011J4
PROJECT NO.:	15-03095.14

BUREAU VERITAS

MAIN

THE HARTF

TH



LEGEND:

- 0–50% FLUORESCENCE RESPONSE
- 50–150% FLUORESCENCE RESPONSE
- 150–250% FLUORESCENCE RESPONSE
- 250%+ FLUORESCENCE RESPONSE
- CPT/ROST™ INVESTIGATION LOCATION NO APPARENT PETROLEUM HYDROCARBON (BLACK)
- CPT/ROST™ INVESTIGATION LOCATION BLUE ROST RESPONSE
- CPT/ROST™ INVESTIGATION LOCATION GREEN ROST RESPONSE
- CPT/ROST™ INVESTIGATION LOCATION YELLOW ROST RESPONSE
- CPT/ROST™ INVESTIGATION LOCATION RED/ORANGE ROST RESPONSE
- INTERPRETED EXTENT OF D CLAY STRATUM (DASHED WHERE EXTRAPOLATED)
- PETROLEUM PIPELINE CORRIDORS (UNDERGROUND)
- INDUSTRIAL SEWER CORRIDOR (UNDERGROUND)

TES:

1. HROST–SERIES BORINGS 1 THROUGH 80 WERE COMPLETED IN 2004 WHILE HROST–SERIES BORINGS 81 THROUGH 130 WERE COMPLETED IN 2005. ALL HROST–SERIES BORINGS WERE COMPLETED BY FUGRO GEOSCIENCES, INC. USING CPT AND ROST™ METHODOLOGY.
2. THE FOLLOWING HROST LOCATIONS 9, 18, 21, 32, 42, 46, 58, 59, 63, 64, 69, 71, 73, 75, 86, 95, 100, 102, 105, 108 AND 127 WERE NOT COMPLETED DUE TO ACCESSIBILITY OR THE LOCATION WAS NO LONGER DEEMED NECESSARY BASED ON NEARBY RESULTS.
3. RESULTS FROM BORINGS ON LEVEE (HROST–81 AND HROST–83) ADJUSTED TO CORRELATE WITH ELEVATIONS OF SURROUNDING TOPOGRAPHY.
4. TWO OR MORE OF THE INDIVIDUAL ROST™ COLORS REPRESENT A COMMINGLED ROST™ RESPONSE.
5. MAP CREATED FROM AERIAL PHOTOGRAMMETRY DATED APRIL 2004 BY CONTINENTAL MAPPING CONSULTANTS, INC.

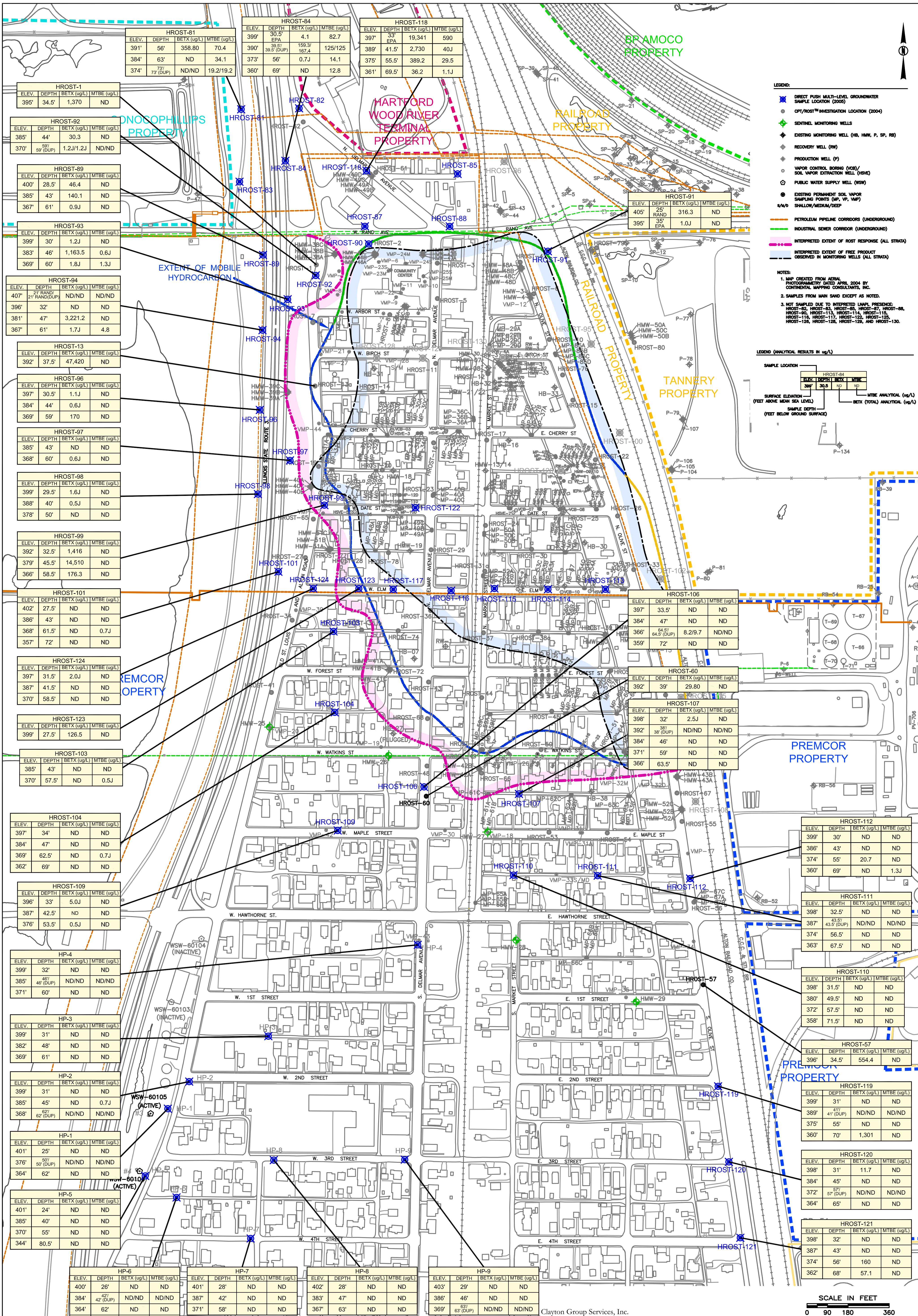
DESIGN BY:	
CHECKED BY:	KDC
DRAWN BY:	BCP
DATE:	12-7-05
SCALE:	AS SHOWN
CAD NO.:	0309514011J5
PROJECT NO.:	15-03095.14

BUREAU VERITAS 1828

ROST RESPONSE IN THE MAIN SAND BELOW THE D CLAY
SEPTEMBER 2005
THE HARTFORD AREA HYDROCARBON PLUME SITE
THE HARTFORD WORKING GROUP
HARTFORD, ILLINOIS

FIGURE

5-5



HROST-81

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
391'	56'	358.80	70.4
384'	63'	ND	34.1
374'	73'/ 73' (DUP)	ND/ND	19.2/19.2

HROST-84

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
399'	30.5' EPA	4.1	82.7
390'	39.5'/ 39.5' (DUP)	159.3/ 167.4	125/125
373'	56'	0.7J	14.1
360'	69'	ND	12.8

HROST-118

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
397'	33' EPA	19,341	590
389'	41.5'	2,730	40J
375'	55.5'	389.2	29.5
361'	69.5'	36.2	1.1J

HROST-1

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
395'	34.5'	1,370	ND

HROST-92

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
385'	44'	30.3	ND
370'	59'/ 59' (DUP)	1.2J/1.2J	ND/ND

HROST-89

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
400'	28.5'	46.4	ND
385'	43'	140.1	ND
367'	61'	0.9J	ND

HROST-91

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
405'	25' RAND	316.3	ND
395'	35' EPA	1.0J	ND

HROST-93

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
399'	30'	1.2J	ND
383'	46'	1,163.5	0.6J
369'	60'	1.8J	1.3J

HROST-94

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
407'	21' RAND/ 21' RAND(DUP)	ND/ND	ND/ND
396'	32'	ND	ND
381'	47'	3,221.2	ND
367'	61'	1.7J	4.8

HROST-13

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
392'	37.5'	47,420	ND

HROST-96

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
397'	30.5'	1.1J	ND
384'	44'	0.6J	ND
369'	59'	170	ND

HROST-97

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
385'	43'	ND	ND
368'	60'	0.6J	ND

HROST-98

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
399'	29.5'	1.6J	ND
388'	40'	0.5J	ND
378'	50'	ND	ND

HROST-99

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
392'	32.5'	1,416	ND
379'	45.5'	14,510	ND
366'	58.5'	176.3	ND

HROST-101

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
402'	27.5'	ND	ND
386'	43'	ND	ND
368'	61.5'	ND	0.7J
357'	72'	ND	ND

HROST-106

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
397'	33.5'	ND	ND
384'	47'	ND	ND
366'	64.5'/ 64.5' (DUP)	8.2/9.7	ND/ND
359'	72'	ND	ND

HROST-124

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
397'	31.5'	2.0J	ND
387'	41.5'	ND	ND
370'	58.5'	ND	ND

HROST-60

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
392'	39'	29.80	ND

HROST-107

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
398'	32'	2.5J	ND
392'	38'/ 38' (DUP)	ND/ND	ND/ND
384'	46'	ND	ND
371'	59'	ND	ND
366'	63.5'	ND	ND

HROST-123

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
399'	27.5'	126.5	ND

HROST-103

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
385'	43'	ND	ND
370'	57.5'	ND	0.5J

HROST-104

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
397'	34'	ND	ND
384'	47'	ND	ND
369'	62.5'	ND	0.7J
362'	69'	ND	ND

HROST-112

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
399'	30'	ND	ND
386'	43'	ND	ND
374'	55'	20.7	ND
360'	69'	ND	1.3J

HROST-109

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
396'	33'	5.0J	ND
387'	42.5'	ND	ND
376'	53.5'	0.5J	ND

HROST-111

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
398'	32.5'	ND	ND
387'	43.5'/ 43.5' (DUP)	ND/ND	ND/ND
374'	56.5'	ND	ND
363'	67.5'	ND	ND

HP-4

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
399'	32'	ND	ND
385'	46'/ 46' (DUP)	ND/ND	ND/ND
371'	60'	ND	ND

HROST-110

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
398'	31.5'	ND	ND
380'	49.5'	ND	ND
372'	57.5'	ND	ND
358'	71.5'	ND	ND

HP-3

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
399'	31'	ND	ND
382'	48'	ND	ND
369'	61'	ND	ND

HROST-57

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
396'	34.5'	554.4	ND

HP-2

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
399'	31'	ND	ND
385'	45'	ND	0.7J
368'	62'/ 62' (DUP)	ND/ND	ND/ND

HROST-119

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
399'	31'	ND	ND
389'	41'/ 41' (DUP)	ND/ND	ND/ND
375'	55'	ND	ND
360'	70'	1,301	ND

HP-1

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
401'	25'	ND	ND
376'	50'/ 50' (DUP)	ND/ND	ND/ND
364'	62'	ND	ND

HROST-120

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
398'	31'	11.7	ND
384'	45'	ND	ND
372'	57'/ 57' (DUP)	ND/ND	ND/ND
364'	65'	ND	ND

HP-5

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
401'	24'	ND	ND
385'	40'	ND	ND
370'	55'	ND	ND
344'	80.5'	ND	ND

HROST-121

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
398'	32'	ND	ND
387'	43'	ND	ND
374'	56'	160	ND
362'	68'	57.1	ND

HP-6

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
400'	26'	ND	ND
384'	42'/ 42' (DUP)	ND/ND	ND/ND
364'	62'	ND	ND
352'	74'	ND	ND

HP-7

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
401'	28'	ND	ND
387'	42'	ND	ND
371'	58'	ND	ND

HP-8

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
402'	28'	ND	ND
383'	47'	ND	ND
367'	63'	ND	ND

HP-9

ELEV.	DEPTH	BETX (ug/L)	MTBE (ug/L)
403'	29'	ND	ND
386'	46'	ND	ND
369'	63'/ 63' (DUP)	ND/ND	ND/ND

Clayton Group Services, Inc.
A Bureau Veritas Company

DESIGN BY:	
CHECKED BY:	KDC
DRAWN BY:	BCP/OS
DATE:	12-31-05
SCALE:	AS SHOWN
CAD NO.:	0309514007b5
PROJECT NO.:	15-03095

BUREAU VERITAS 1828

GROUNDWATER GRAB SAMPLE RESULTS
2004 AND MAY-AUGUST 2005

THE HARTFORD AREA HYDROCARBON PLUME SITE
THE HARTFORD WORKING GROUP
HARTFORD, ILLINOIS

FIGURE 5-6